Contagion, Channels of Shock Transmission and Structure of Channel Performance

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ABSTRACT

Contagion among countries and sectors when a financial crisis breaks out is currently under scrutiny. The existing literature focuses on establishing the existence of contagion among equity markets but relatively little attention is devoted to examining which channels spread the shock to individual sectors. This study extends the literature by estimating a time-series of contagion for sectors identified as contagious, investigating three potential channels of shock transmission and investigating the role of the channels as the severity of contagion increases. Using data for 16 emerging markets and nine industrial sectors for the 2007-2009 financial crisis, we find that the global channel provides a mechanism that stabilizes and mitigates contagion while the country channel is the primary force encouraging contagion and the sector channel is ineffective. We also find the role of each channel may change as the severity of contagion increases.

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1. Introduction

The 2007-2009 financial crisis led to a global financial tsunami that highlighted the increasing co-movement of markets both within and across countries. A significant increase in co-movement in response to a financial crisis is termed contagion. Investigating the contagion phenomenon, from identification to transmission and structure, among countries and sectors is an important research area to facilitate comprehension of information flow and risk management.

Previous studies have shown evidence of contagion during the 2007-2009 financial crisis. This thesis goes further and estimates a time series of contagion in order to examine the shock transmission behind contagion. There is disagreement over which channel is the most important in shock transmission. ***Baca et al. (2000), Cavaglia et al. (2000), Kaltenhauser (2002), Choudhry et al. (2010), Black et al. (2002)*** and ***Phylaktis and Xia (2006)*** argue that sector effects are stronger than country effects, while ***Berger and Pozzi (2013)*** and ***King et al. (1994)*** propose the opposite. Inspired by these studies and motivated by ***Phylaktis and Xia (2009)*** and ***Bekaert et al. (2005),*** we use sector, country and global idiosyncratic risks as proxies for three channels that may carry and spread contagion during the 2007-2009 crisis. In addition, following ***Li et al. (2004)*** and ***Morck et al. (2000),*** we investigate the relationship between the channels of shock transmission and market openness.

We also study the channels of shock transmission from a micro-perspective. We investigate the structure of channel performance in two ways: Is the individual channel impact consistently positive or negative and does any channel dominate as the severity of contagion increases? To the best of our knowledge, our study is the first to investigate channel performance at different degrees of contagion.

The remainder of this thesis is organized as follows: Chapter 2 summarizes the literature, which consists of three strands: Detection of contagion, potential channels spreading contagion, and the structure of channel performance. The hypotheses and data are in Chapter 3 and Chapter 4, respectively. Chapter 5 explains the analytical models and empirical findings. Chapter 6 presents robustness checks. Chapter 7 concludes and indicates implications while Chapter 8 discusses limitations and recommendations for future studies.

2. Literature Review

Chapter 2 summarizes three strands of literature. Our goal is to investigate the channels spreading contagion and the structure of channel dominance. To reach our goal, first, we investigate the existence of contagion. Second, we study the potential channels transmitting shocks to an individual sector from its financial sector. Third, we investigate the structure of channel dominance. The three literature streams presented below respond to these research questions in sequence.

2.1 Detection of contagion

There is no consensus on the definition and the measurement of contagion. Possible definitions of contagion include: 1) Contagion is a significant increase in co-movements of prices and quantities across markets, conditional on a crisis occurring in one market or group of markets ***(Forbes and Rigobon, 2001)***; 2) Contagion occurs when co-movements cannot be explained by fundamentals (***Bekaert, 2005)***; 3) Contagion occurs when volatility spills over from the crisis country to the financial markets of other countries ***(Chancharoenxhai and Dibooglu, 2006)***.

The ***Forbes and Rigobon (2001)*** contagion definition is the most widely used and is followed in this study. Based on their work, correlation coefficients have provided a base for the measurement of contagion. For example, using correlation coefficients, ***Berben and Jansen (2005)*** investigate the contagion among international equity returns at market and industrial levels during the 1980 to 2000 period. They find that the correlations among the German, UK and US stock markets have more than doubled during the period, while the correlation between the Japanese and the other three markets remains unchanged. Moreover, the correlations at the aggregate level broadly reflect similar behavior at the industry level. Cross-country industry correlations of Germany, the UK and the US have either gone up or remained the same, while the sector correlations of Japan with these three countries have not changed. ***King and Wadhwani (1990), Lee and Kim (1993), Baig and Goldfajn (1999)*** and ***Loretan and English (2000***) also use correlation coefficients to investigate contagion and find varying results depending on the crisis, industries and countries studied.

A modified correlation coefficient has been proposed to counter the heteroskedasticity-induced bias in the standard correlation coefficient measurement of contagion. ***Forbes and Rigobon***

(2002) use adjusted correlation to measure contagion and study the 1997 Asian crisis, the 1994 Mexican devaluation, and the 1987 U.S. market crash. They conclude that there is only a high level of market interdependence but not contagion when the adjusted metric is used.

Regression analysis with interaction dummy variables is another approach to measuring contagion. ***Baur (2012)*** and ***Baur (2013)*** use a finance sector return interacting with a crisis dummy to detect contagion. These two studies assume the 2007-2009 global financial crisis (GFC) starts from the financial sector and estimate changes in the return co-movement of specific sectors with the global financial system or the domestic financial system. ***Baur (2012)*** studies the spread of the GFC and explores the contagion phenomenon between the financial sector and sectors of the real economy in a sample of twenty-five major developed and emerging stock markets. He finds that no sector and country are immune to the 2007-2009 crisis but healthcare, telecommunication, and technology sectors are the least affected.

Berkaert et al. (2005) and ***Phylaktis and Xia (2009)*** believe contagion is excessive correlation beyond that explained by economic fundamental movement. Therefore, they measure contagion by calculating the correlation coefficient between the residuals of regressions representing economic fundamentals. ***Berkaert et al. (2005)*** investigate country level contagion during the Mexican and Asian crises and show there is no evidence of contagion during the Mexcian crisis while contagion occurs during the Asian crisis. ***Phylaktis and Xia (2009)*** study equity market co-movement and contagion at the sector level during the 1990-2004 period across the regions of Europe, Asia, and Latin America. They detect contagion at the sector level in these regions.

We follow the contagion definition of ***Forbes and Rigobon (2001)*** and the methodology of ***Baur (2012)*** by using a regression framework with an interaction term (finance sector return with a crisis dummy) to capture contagion. The details are presented in Chapter 5.

Once contagion is detected, the Kalman filter is used to estimate its time-varying path. The resulting contagion time series will be used to investigate potential channels that may spread contagion to individual sectors. Chapter 2.2 discusses the literature about sector, country, and global effects as potential macroeconomic channels of shock transmission.

2.2 Channels of shock transmission

In previous studies, industry, country and global factors are frequently associated with equity returns and they are considered potential transmission mechanism that spread contagion. However, these studies disagree as to which channel is the most important in shock transmission.

Phylaktis and Xia (2006) exemplify the literature stream that examines country versus industry effects in international equity markets of 34 countries from 1992 to 2001. They find that after 1999 there is a shift in dominance from country effects to industry effects in Europe and North America, while in Asia Pacific and Latin America, country effects still dominate. Similar to ***Phylaktis and Xia (2006)***, ***Baca et al. (2000)*** study the importance of sector and country effects, in driving country equity market returns during 1979-1999. They find a significant decline in country effects on the stock returns of the largest global markets, while sector effects did not change in that period. ***Cavaglia et al. (2000)*** report similar results**.** During 1986-1999, industry factors grew in relative importance and were comparable with country factors. Furthermore, all three studies suggest that diversification across sectors may provide greater risk reduction than diversification across countries.

Kaltenhauser (2002) also highlights the importance of sector effects. His study estimates the time-varying spillover effects from European and US return innovations to ten economic sectors from January 1988 to March 2002 within the Euro area, US and UK. The results lend support to the increasing importance of sector-specific effects with the start of the European Monetary Union. Moreover, they find that basic industries, non-cyclical consumer goods, resources and utilities are less affected by aggregate shocks.

In contrast to the research that shows an increasing sector role, many studies emphasize the importance of country effects. Although ***Roll (1992)*** proposes that sector effects drive markets returns, ***Heston and Rouwenhorst (1994)*** question his findings. Roll uses daily data and investigates 24 country indexes from April 1988 through March 1991. The study shows that industry effects are important and explain approximately 40% of return variation. However, ***Heston and Rouwenhorst (1994)*** use different samples and periods and demonstrate that ***Roll (1992)*** did not separate the country effects from industry effects, thus overstating the importance of industry effects. Moreover, they show that country effects such as fiscal, monetary, legal, cultural and language differences are more important than industry effects in explaining return variation. Consistent with ***Heston and Rouwenhorst (1994)***, ***Griffin and Karolyi (1998)*** confirm that sector effects are not important, while industry effects vary across different categories of industries. Specially, the traded-goods industries tend to be more susceptible to industry effects.

In addition to sector and country effects, ***Choudhry et al. (2010)*** and ***Phylaktis and Xia (2009)*** investigate global effects. ***Choudhry et al. (2010)*** studies how the sector effect (measured by conditional volatility of the individual industry sector), country effect (measured by market conditional volatility) and global effect (measured by global factor volatility) impact Asian industrial sectors against the background of the Asian financial crisis of 1997-1998. They find that during the crisis period, the sector effect is significantly positive, the country effect shows a negative impact and the global effect is insignificant. ***Phylaktis and Xia (2009)*** also define the global, regional, and sector idiosyncratic volatilities as three potential channels transmitting the shock leading to contagion. They conclude that contagion tends to come from regional channels in Europe and Asia while it mainly transmits through global channels in Latin America.

In summary, depending on the crisis and the time period, previous studies support country, sector and global effects in shock transmission. This thesis synthesizes the literature and combines global, country and industry effects as three potential channels that transmit the shock to individual sectors from the financial sector and cause variation in equity market returns, to investigate channel performance in shock transmission during the 2007-2009 crisis. Identifying channel roles will assist regulators and individual investors in formulating risk management policies and strategies.

Once we have characterized the various channels during the crisis, we investigate whether each channel shifts its role of encouraging and discouraging contagion as the degree of contagion changes. In our study, this is called the structure of channel performance. Chapter 2.3 reviews the relevant literature.

2.3 Structure of channel performance

Many studies, including ***Goetzmann et al. (2001), Baur (2013), Li et al. (2014), and Morck et al. (2000),*** show that world market co-movements have changed over time or with market openness**.** ***Goetzmann et al. (2001)*** demonstrates that the correlation structure has changed in response to increased market integration***. Baur (2013)*** uses quantile regression to estimate the degree and structure of dependence of 54 global equity markets returns in normal and crisis periods. The results show that contagion occurs in the 54 markets during the 2007-2009 crisis. Further, during a crisis the structure of dependence is tempered for emerging markets but relatively unchanged for developed markets. Adapting the quantile regression approach allows us to investigate whether each channel shifts its role of encouraging and discouraging contagion as the degree of contagion changes. We call this the structure of channel performance. Exploration of the channel structure fills a gap in the existing literature and explores shock transmission from a micro-perspective.

2.4 Summary

Utilizing the ***Forbes and Rigobon (2001)*** definition of contagion and the regression approach of ***Baur (2012)***, we identify contagious and non-contagious sectors. Increased linkages among markets during a crisis will decrease the opportunities for international diversification (***Ahlgren and Antell, 2010)***. Understanding such linkages is especially important for regulators and individuals to find effective ways for diversification. First, if some sectors are found to be non-contagious with the financial sector, these sectors are a "safe haven" for risk diversification during the crisis. Second, through investigating the shock transmission performance of the three idiosyncratic risk factors, we can provide suggestions to manage channel risks. Finally, by studying the structure of channel performance, we go one-step further in exploring the characteristics of contagion from a micro-perspective.

3. Hypotheses development

Prior studies find evidence of contagion at the country and sector levels in the 2007-2009 crisis. ***Baur (2012)*** and ***Baur (2013)*** identify and differentiate the U.S. financial sector and the individual country's own financial sector as two potential origins of contagion. In our study, we target emerging markets and the contagion phenomenon at the sector level, but we only focus on the contagion originating from the country's own financial sector. Thus, we begin by determining which individual sectors are contagious with the country's own financial sector. As stated earlier, our contagion identification depends on the definition of contagion put forward by

Forbes and Rigobon (2001): Contagion is a significant increase in market co-movement after a shock to a country. Hence, we start by hypothesizing the following:

Hypothesis $\mathbf{1_0}$: *Within a given country, there is no significant increase in co-movement between a sector and its financial sector. (No contagion)*

Hypothesis $\mathbf{1_a}$: *Within a given country, there is a significant increase in co-movement between a sector and its financial sector. (Contagion)*

Many studies have already shown that during a crisis, contagion occurs at the sector level, particularly for emerging economies. We expect to find contagious sectors as well as non-contagious sectors.

Once contagion is identified, we estimate its time series path and then we investigate the channels that spread contagion. In addition, we study whether there is a channel that provides a mechanism for discouraging or mitigating contagion. Motivated by ***Phylaktis and Xia (2006)*** and ***Bekaert et al. (2005),*** we use idiosyncratic risks of sector, country and global as proxies for three channels of shock transmission. There is no consensus in the previous literature as to what effects are the most important in shock transmission. ***Baca et al. (2000), Cavaglia et al. (2000), Kaltenhauser (2002), Choudhry et al. (2010)***, ***Black et al. (2002)*** and ***Phylaktis and Xia (2006)*** argue that sector effects are stronger than country effects in affecting equity returns. ***Berger and Pozzi (2013)*** and ***King et al. (1994)*** argue the opposite. Meanwhile, ***Choudry et al. (2010) and Phylaktis and Xia (2009)*** find that global effects are insignificant for Asia but ***Phylaktis and Xia (2009)*** support them for Latin America. Based on these studies, we investigate whether sector, country and global channels have roles to play in affecting contagion during the 2007-2008 crisis.

Additionally, ***Li et al. (2004)*** state that markets with higher level of openness tend to co-move more aggressively, while ***Morck et al. (2000)*** find the opposite. ***Phylaktis and Xia (2009)*** find that sectors in some regions are more responsive to the global economy. These studies inspire us to investigate the impact of market openness on the channels of transmission and their structure. The definition and categorization of open economies is discussed in Chapter 4.

Based on these studies, we propose the following:

Hypothesis $\mathbf{2_0}$: As the degree of market openness increases, sector effects are at least as prominent as country or global effects.

Hypothesis $\mathbf{2_a}$: As the degree of market openness increases, sector effects are less prominent than country or global effects.

We expect hypothesis 2_0 to be favored because, as proposed in ***Phylaktis and Xia (2006),*** with increasing market integration and business globalization, country effects are diminishing while the industry effects are more relevant in global business cycles. Alternately stated, in a more closed economy, industries are not integrated into the global markets and contagion is more likely transmitted through a country rather than a sector channel.

Next, we study channel performance from a micro-perspective, which, following ***Baur (2013)***, is called the structure of channel performance. We investigate the behavior of the three channels at different degrees of contagion. If a channel always performs the same function as the degree of contagion changes, the structure of channel performance remains unchanged.

Hence, we propose the following:

Hypothesis $\mathbf{3_0}$***:*** *At different degrees of contagion, a channel (sector, country or global channel) always encourages/discourages contagion. (Structure of the channel's performance remains unchanged)*

Hypothesis $\mathbf{3_a}$***:*** *At different degrees of contagion, a channel (sector, country or global channel) shifts its role of encouraging and discouraging contagion. (Structure of the channel's performance changes)*

We expect heterogeneous results, depending on how quickly and effectively regulators and individual investors react, which in turn will reflect numerous factors including market efficiency, liquidity, trade and finance linkages, and the symmetry of information flows.

4. Data

Empirical analysis is conducted on the sector returns for a set of 16 emerging markets from Nov 1, 2001 to June 30, 2009. Morgan Stanley Capital International (MSCI) gives the classification of emerging markets. MSCI categorizes markets into frontier, emerging, and developed markets based on three criteria: level of economic development, market size and liquidity requirement, and market accessibility. The emerging markets include Brazil, Chile, Colombia, Czech Republic, Greece, Hungary, Poland, Russia, South Africa, Turkey, China, India, Korea, Malaysia, Philippines, and Thailand. According to MSCI emerging markets classification criteria, emerging markets are identified as markets with significant openness to foreign ownership, significant ease of capital inflow or outflow, good market efficiency and modest stability of the institutional framework. Therefore, we can safely conclude that an emerging market identified in MSCI is also an open market. This provides a prerequisite to group our findings by different levels of market openness. We follow Datastream's distinction of 10 economic sectors: 1) oil and gas, 2) basic materials, 3) industrials, 4) consumer goods, 5) health care, 6) consumer services, 7) telecommunications, 8) utilities, 9) financials, and 10) technology. The details of sector and industry classification are in Appendix A.

The GFC dates are from to the National Bureau of Economic Research (NBER) and ***Baur (2012)***. The NBER committee takes Nov. 2001 as the start of economic expansion, defined as the beginning of rising real GDP, real income, employment, industrial production, and wholesale-retail sales ***(NBER, 2003)***. ***Baur (2012)*** combines timelines offered by the ***Federal Reserve Board of St. Louis (2009)***, the ***Lauder Institute at Wharton and the Bank for International Settlements (2009)***, and ***Guillen (2009)***. These studies argue that liquidity deterioration occurred in the money market and led to an announcement by the Federal Open Market Committee, downgrading banks and declaring the subprime mortgage crisis in early Sept. 2007. Therefore, we set Nov. 2001 to Aug. 2007 as the pre-crisis period and from Sept. 2007 to June 2009 as the crisis period. Other series, including the 3-month T-bill rate, exchange rates, Moody's Baa bond yield, Moody's Aaa bond yield, US 10-year bond yield, and the 30-day Eurodollar rate are obtained from Datastream.

Consistent with previous literature, the categorization of market openness is obtained from the MSCI database and 2013 International Chamber of Commerce open markets index (OMI). The index measures the market openness by comprehensively considering the following factors as indications of trade openness, trade policy, foreign direct investment openness and infrastructure for trade. Based on their OMI scores, each country falls into one of the following five groups.

Category 1: Most open, excellent (score of 5-6).
Category 2: Above average openness (Score 4-4.99).
Category 3: Average openness (Score 3-3.99).
Category 4: Below average openness (Score 2-2.99).
Category 5: Very weak (Score 1-1.99).

Our sample countries are scored (in brackets) and categorized as follows:

Category 2: Hungary (4.2), Czech Republic (4.2).
Category 3: Malaysia (3.9), Chile (3.9), Poland (3.8), Korea (3.6), Turkey (3.4), Greece (3.2), Thailand (3.2), South Africa (3.2), Colombia (3.0).
Category 4: China (2.8), Philippines (2.8), Russia (2.8), India (2.5), Brazil (2.1).

5. Methodology and Empirical Findings

This chapter is composed of three parts: Models of contagion detection, three channels of shock transmission, and channel performance structure.

Our ultimate goal is to analyze the channels of shock transmission as well as the structure of channel dominance through regression analysis of the following relationship*:* $Contagion\ magnitude = \gamma_1 Channel_1 + \gamma_2 Channel_2 + \gamma_3 Channel_3$. The dependent variable is contagion magnitude. The independent variables ($Channel_1$, $Channel_2$ and $Channel_3$) are the idiosyncratic risks of the three channels. Before we can estimate this relationship, we have to estimate contagion magnitude and the idiosyncratic volatilities of the three channels separately. These topics are covered as follows: Chapter 5.1 presents the contagion detection model. Chapter 5.2 explains the method of estimating contagion magnitude and the approach for estimating the three channels. Chapter 5.3 presents the model used to analyze the structure of channel dominance as well as relevant empirical findings.

5.1 Contagion Detection

We use the ***Forbes and Rigobon (2001)*** definition of contagion and the regression approach of ***Baur (2012)*** to detect contagion between a financial sector and an individual sector during the

2007-2009 crisis.[1] The coefficient of the interaction term, $\beta_{2_{i,j}}$, in the following model measures contagion during the crisis.

$$R_{i,j,t} = \beta_{0_{i,j}} + \beta_{1_{i,j}} R_{fin,j,t} + \beta_{2_{i,j}} R_{fin,j,t} * D_{crisis,t} + \beta_{3_{i,j}} D_{crisis,t} + \beta_{4_{i,j}} R_{US_{MK},t} + \varepsilon_t \quad (1)$$

i is sector, j is country, t is time and $R_{US_{MK},t}$ is the U.S. market return.

The model suggests the following process: The return of an individual industry index i in country j ($R_{i,j,t}$) is regressed on the financial sector return of country j ($R_{fin,j,t}$), to assess the impact of the financial sector of country j on individual sectors within country j. In addition, to control for the impact of the global economy on the individual sector i, we include the global market return (measured by $R_{US_{MK},t}$). The crisis period is distinguished by a dummy variable. Within the crisis period, $D_{crisis,t} = 1$, otherwise $D_{crisis,t} = 0$. There are two terms related to the crisis in the regression, an interaction term $R_{fin,j,t} * D_{crisis,t}$ and $D_{crisis,t}$. The rationale behind these two terms is that the 2007-2009 crisis not only impacts sector returns on average but also the rate at which the financial sector influences the different individual sectors. $\beta_{2_{i,j}}$ is the coefficient of $R_{fin,j,t} * D_{crisis,t}$ and captures this additional effect. Thus, according to the definition of contagion put forward by ***Forbes and Rigobon (2001)***, $\beta_{2_{i,j}}$ is the key to detecting contagion. Therefore, hypothesis 1 can be restated as:

Hypothesis $\mathbf{1_0}$***:*** $\beta_{2_{i,j}} \leq 0$*, there is no contagion between an individual sector and its financial sector.*

Hypothesis $\mathbf{1_a}$***:*** $\beta_{2_{i,j}} > 0$*, there is contagion between an individual sector and its financial sector.*

The null describes the condition that contagion does not occur. The alternative describes that contagion occurs: a significant increase in dependence between the financial sector and an individual sector as the crisis breaks out. Our first step is to estimate equation (1) for the full period from Nov. 2001 to June 2009 to identify contagious as well as non-contagious sectors.

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[1] We do Granger Causality tests to investigate whether there is any feedback from an individual sector to its financial sector for each of the sixteen emerging markets. The results are in Table 12. There are very few cases of feedback from individual sectors to the financial sector at a 5% significance level. Therefore, we do not take feedback into account.

5.1.1 Empirical results of contagion detection (Hypothesis 1)

Table 1 presents the results of contagion detection for a total of 126 country and industry combinations (16 countries and a maximum of 9 industrial groups per country). Approximately 36% of all sectors studied exhibit a positive and significant $\beta_{2_{i,j}}$, which is consistent with previous studies that find mixed results for contagion at sector levels during the 2007-2009 crisis ***(Baur, 2012; Baur, 2013)***.[2] For example, the $\beta_{2_{i,j}}s$ of the Chinese basic materials, industrials, consumer goods, consumer services and utilities sectors are statistically positive, which implies these sectors are contagious with the Chinese financial sector. In India, only the industrials sector has a positive and significant $\beta_{2_{i,j}}$, thus this sector is contagious with the Indian financial sector. Across industries, the oil and gas (8 of 16 emerging markets), basic materials (7 of 16), and industrials (7 of 16) classifications are the most frequently affected during the 2007-2009 crisis. In contrast, none of the sixteen emerging markets has its technology sector identified as contagious. ***Phylaktis and Xia (2006)*** suggest that the technology group result represents anomalous and temporary behavior caused by IT bubbles.

There are only two emerging markets, Brazil and Greece, that demonstrate no evidence of contagion at the sector level. These non-contagious sectors and countries were a "safe haven" for investors to shift into in order to diversify risk during the 2007-2009 crisis. The countries with the most sectors showing contagious behavior are Chile (7 sectors), Hungary (6), Thailand (5) and China (5). These results are similar to ***Baur (2012).***

[Insert Table 1 Here]

5.2 Investigating channel performance

In addition to detecting contagion, we are interested in investigating the potential channels that spread contagion. To proceed, we need to estimate a time-series of contagion for each contagious sector (the dependent variable), and three potential channels of shock transmission (independent variables) for our channel transmission regressions. In Chapter 5.2.1, we use the Kalman filter to estimate time-series of contagion for each appropriate sector. In Chapter 5.2.2, we present global,

[2] Mixed results for contagion surrounding other crises are also common ***(Kaminsky et al, 2003)***.

sector and country models to estimate the three channels. In Chapter 5.2.3, we present the relevant empirical results of channel performance.

5.2.1 Kalman Filter Estimation of contagion

The pre-crisis period is from Nov. 2001 to Aug. 2007, totaling 305 weeks. The crisis period is from Sept. 2007 to June 2009, totaling 95 weeks. We use the Kalman filter to estimate a time-series of contagion ($\beta_{2_{i,j}}$) during the crisis period for each country and industry that is identified as contagious.

The Kalman filter extracts the signal or relevant information from newly revealed and noisy data in order to update, in this case, the estimate of contagion. Kalman filter estimation is a recursive procedure and requires initial values for $\beta_{2_{i,j}}$, the variance of $\beta_{2_{i,j}}$, and the variance of the error in the measurement equation (equation (1)). There are numerous ways to obtain initial values. Our approach uses the estimates from full sample estimation of equation (1). The key equations and assumptions of the Kalman filter are in Appendix B. [3] Using the updating equations in Appendix B, we first calculate 477 estimates of each relevant daily $\beta_{2_{i,j}}$ during the crisis period and then convert these to 95 weekly $\beta_{2_{i,j}}$ for each country and industry combination.

Once we have a time-series of contagion, we investigate how the crisis of the financial sector transmits to the individual sectors during the crisis period. We identify three potential channels and use sector, country and global idiosyncratic volatilities to proxy these three channels. Chapter 5.2.2 provides the methodology for estimation of the idiosyncratic volatilities as well as the corresponding rationale.

5.2.2 Channels of shock transmission-the sector, country and global models

Following ***Phylaktis and Xia (2009), Phylaktis and Xia (2006)*** and ***Bekaert et al. (2005)***, we use idiosyncratic volatilities as proxies for sector, country and global channels. The rationale behind using idiosyncratic volatilities as proxies for sector and country channels is that idiosyncratic volatilities represent unsystematic risks that can be mitigated or eliminated with appropriate

[3] This is a common procedure. Further, the initial values are less important the longer the recursion period. We have a long recursion period of 400 weeks of daily observations. We choose the optimal Kalman filter estimate according to the signal to noise ratio that maximizes the log likelihood.

diversification strategies. For example, if the contagion of an industry is identified as being transmitted through its country channel, the local government can set specific regulations and policies to reduce the country idiosyncratic volatility, which should in turn reduce the industry contagion transmitted via the country channel. If the contagion of a sector is identified as spreading from the industry channel, the policy maker can diversify the sector specific risk by sector regulation, which may mitigate the contagion transmitted from the sector channel. In this scenario, an individual investor might consider international diversification as opposed to an industry diversification strategy. The risk of the world market is composed of all countries and sectors and thus its risk is considered non-diversifiable. Thus, if contagion is transmitted through the global channel, local government intervention is insufficient. If any channel is found to discourage contagion, then that channel provides a mechanism that automatically stabilizes and mitigates contagion.

Estimation of the risks for the three channels is consistent with ***Phylaktis and Xia (2009), Phylaktis and Xia (2006)*** and ***Bekaert et al. (2005).*** First, we build sector, country and global models and obtain residuals from each model. Secondly, we model the volatilities of the residuals from these three models using GARCH analysis. The GARCH estimated volatilities are the proxies of the sector, country and global channels.

The country and global models are derived on the basis of a two-factor asset pricing model developed in ***Bekaert et al. (2005)*** and ***Phylaktis and Xia (2009)***. The models developed in ***Bekaert et al. (2005)*** nest a world capital asset pricing model (CAPM), and a national CAPM with a national portfolio benchmark. ***Phylaktis and Xia (2009)*** apply ***Phylaktis and Xia (2006)*** and ***Bekaert et al. (2005)*** to develop a sector model in addition to the country and global models to examine sector level activities. We combine their models and specify our sector, country and global models accordingly.

The sector model:

Bekaert et al. (2005) and ***Phylaktis and Xia (2009)*** indicate that a sector return can be explained by the fundamentals and the risky components (CAPM components) of the sector. The fundamentals of the sector model contain a set of local economic information variables, as proxied by the lagged sector return and the market dividend yield.[4] According to ***Fama and French (1988), Hodrick (1992), Park et al. (2010), Lemmon et al. (2008)***, dividend yield is a good predictor of stock market returns, thus we include the market dividend yield as a fundamental variable. In addition, we include the lagged sector return as a fundamental variable to capture any trending of the sector. Based on ***Phylaktis and Xia (2009)***, we also include the country's own market excess expected return and the residual of its market excess return forecast in the risky components of the sector model. These two terms capture country and global economic movement, respectively.[5] Our model has the following specification:

$$r_{i,j,t} = \boldsymbol{\delta_{i,j}}'\boldsymbol{X_{i,j,t-1}} + \omega^{j}_{1_{i,j,t-1}}\mu_{j.t-1} + \omega^{j}_{2_{i,j,t-1}}e_{j,t} + e_{i,j,t} \,, \tag{2}$$

$r_{i,j,t}$ is the return of sector i in country j in excess of country j's 3-month T-bill rate, $\boldsymbol{\delta_{i,j}}'$is a row vector of coefficients and vector $\boldsymbol{X_{i,j,t-1}}$ includes a constant, lagged sector return and market dividend yield. The expected returns on the market of country j in excess of country j's 3-month T-bill rate, conditional on information available at time $t-1$, is $\mu_{j,t-1}$. $\mu_{j,t-1}$is measured by taking the average of market returns from time 1 to time $t-1$. The residual of market excess return of country j is $e_{j,t}$. $e_{j,t}$ is obtained by subtracting $\mu_{j,t-1}$ from the revealed market return at time t. All the excess returns are expressed in U.S. dollars.

We save the residual ($e_{i,j,t}$) of equation (2), which is conditional on all the information available at time t -1 (Ω_{t-1}).

$$e_{i,j,t}|\Omega_{t-1} \sim N(0, \sigma^2_{i,j,t}), \tag{3}$$

In equation (4), we implement asymmetric GARCH (1, 1)[6] to model the volatility of the residual obtained from equation (2). The volatility obtained is the idiosyncratic volatility of the sector. It is used to proxy the sector channel.

[4] Market dividend yield of a country is calculated by subtracting the sum of industries returns of that country from the total market return.

[5] We find market excess expected return and the forecast error of the market excess return are highly correlated to the global market excess expected return and the forecast error of the global market excess return respectively. Therefore, we only include market excess expected return and the forecast error of the market excess return in the sector model.

[6] The details of choosing the GARCH model are in the robustness section.

$$\sigma_{i,j,t}^2 = a_{i,j} + b_{i,j}\sigma_{i,j,t-1}^2 + c_{i,j}e_{i,j,t-1}^2 + d_{i,j}\eta_{i,j,t-1}^2. \tag{4}$$

Where $\eta_{i,j,t}$ captures the asymmetric and negative information of the sector i and $\eta_{i,j,t} = \min(0, e_{i,j,t})$ ***(Phylaktis and Xia, 2009; Bekaert et al., 2005).***

This process orthogonalizes the sector from the country and global factors and will be repeated for the other two channels. Using orthogonal factors in the channel performance regressions (equation 11) will allow independent assessment of each channel's impact.

The country model:

The country model is composed of fundamental factors, world market risk components and a residual. The country model is derived from the international CAPM (ICAPM) and takes foreign currency risk into account. The fundamental factors include a market dividend yield and an exchange rate. ***Solnik (1974)*** shows that exchange rate risk should be taken into account when pricing a country's equity return. For the same reason, ***Ferson and Harvey (1993),*** in examining the predictability in country equity market returns and its relation to global economic risk, include an exchange rate as a fundamental of a country's equity return. Similarly, ***Dumas and Solnik (1995)*** investigate the validity of exchange rate risk priced in an ICAPM and propose that exchange rate risk is a significant component of market return in the international equity market.

To examine the independent impact of the country channel we follow ***Phylaktis and Xia (2009)*** and take out the global risky components (global market excess expected return and the residual of global market excess expected return) from the country model.[7] The model is specified in equation (5).

$$r_{j,t} = \boldsymbol{\delta_{j,t}}'\boldsymbol{X_{j,t-1}} + \omega_{1_{i,j,t-1}}^{w}\mu_{w,t-1} + \omega_{2_{i,j,t-1}}^{w}e_{w,t} + e_{j,t}, \tag{5}$$

$r_{j,t}$ is the return of country j in excess of country j's 3-month T-bill rate, $\boldsymbol{\delta_{j,t}}'$ is a row vector of coefficients and $\boldsymbol{X_{j,t-1}}$ is the information set for country j, which contains a constant, the market dividend yield and the lagged exchange rate. The expected return on the global market in excess of country j's 3-month T-bill rate, conditional on information available at time $t-1$, is

[7] It is naturally accepted that sector information is included in the country market movement, which is already captured by fundamentals of the country. Thus, we do not need to include these sector factors separately in equation (5).

$\mu_{w,t-1}$. Expected returns at time t on the global market are measured by averaging the global market returns from time 1 to $t-1$. The residual of the excess expected return of the global market is $e_{w,t}$. $e_{w,t}$ is obtained by subtracting $\mu_{w,t-1}$ from the global market return at time t. All the excess returns are expressed in U.S. dollars. We save the residual of equation (5), which is conditional on all the information available at time t -1 (Ω_{t-1}).

$$e_{j,t}|\Omega_{t-1} \sim N(0, \sigma_{j,t}^2), \tag{6}$$

Asymmetric GARCH (1, 1), equation (7), is used to model the residuals obtained from equation (5).[8] The resulting volatility estimates represent the country idiosyncratic volatilities and are proxies for the country channel.

$$\sigma_{j,t}^2 = a_j + b_j \sigma_{j,t-1}^2 + c_j e_{j,t-1}^2 + d_j \eta_{j,t-1}^2. \tag{7}$$

Where $\eta_{i,t}$ captures the asymmetric and negative information of the country market and $\eta_{i,t} = \min(0, e_{j,t})$ ***(Phylaktis and Xia, 2009; Bekaert et al., 2005).***

The global model:

The global model is composed of world market fundamentals and the idiosyncratic shock of the world market. World fundamentals are proxied by U.S. factors because the U.S. is still the most powerful economy in the world (***Bekaert et al., 2005; Phylaktis and Xia, 2009)***.

Following ***Bekaert et al. (2005)*** and ***Phylaktis and Xia (2009)***, we use the U.S. dividend yield, the default spread (Moody's Baa minus Aaa bond yields), the change in the term structure spread (U.S. 10-year bond yield minus 3-month U.S. T-bill rate), and the change in the 30-day Eurodollar rate to be the economic fundamental factors of the world market. These variables are commonly used in the literature to capture the fluctuations of the world economy (***Ferson and Harvey, 1992)***.

Because the concept of global economies includes country and sector factors, we believe that the fundamental variables of the global model have captured sector and country factors. Our model is described as follows.

[8] The details of choosing the GARCH model are in the robustness section.

$$r_{wd,t} = \boldsymbol{\delta_{wd,t}}'\boldsymbol{X_{wd,t-1}} + e_{wd,t}, \tag{8}$$

$r_{wd,t}$ is the world market return in excess of the 3-month U.S. T-bill rate.[9] Vector $\boldsymbol{X_{wd,t-1}}$ is a set of world information variables including a constant, U.S. dividend yield, the default spread (Moody's Baa minus Aaa bond yields), the change in the term structure spread (US 10-year bond yield minus 3-month U.S. T-bill rate) and the change in the 30-day Eurodollar rate.
We save the residual of equation (8), which is conditional on all the information available at time t -1 (Ω_{t-1}).

$$e_{wd,t}|\Omega_{t-1} \sim N(0, \sigma^2_{wd,t}), \tag{9}$$

Equation (10) represents the asymmetric GARCH (1, 1) used to model the volatility of the residuals obtained in equation (8).[10] The volatility obtained is the idiosyncratic volatility of the world and proxies the global channel.

$$\sigma^2_{wd,t} = a_{wd} + b_{wd}\sigma^2_{wd,t-1} + c_{wd}e^2_{wd,t-1} + d_{wd}\eta^2_{wd,t-1}. \tag{10}$$

$\eta_{wd,t}$ captures the asymmetric and negative information of the country market and $\eta_{wd,t} = \min(0, e_{wd,t})$ ***(Phylaktis and Xia, 2009; Bekaert et al., 2005).***

To summarize, $\sigma_{i,j,t}, \sigma_{j,t}$ and $\sigma_{wd,t}$, calculated using asymmetric GARCH(1,1) (equations (4), (7) and (10)) are estimates of idiosyncratic risks of sector, country and global factors and are proxies for the three shock transmission channels.

Once we have time series of contagion, and estimates of the sector, country and global channels, we can address one of the main questions pursued in this thesis: How do the three channels perform and transmit contagion during the 2007-2009 crisis?

5.2.3 Empirical results of channel dominance (Hypothesis 2)

In Chapter 5.2.3, we investigate how the three potential channels transmit contagion during the financial crisis. In addition, we study whether channel performance is related to market openness and industrial classification. The contagion series estimated in Chapter 5.2.1 are the dependent

[9] The world market return is from Datastream World Market Index.
[10] The details of choosing the GARCH model are in the robustness section.

variables, while the three channels estimated in Chapter 5.2.2 are the independent variables.[11] Our model has the following specification: [12]

$$Contg_{i,j,t} = \alpha_{0_{i,j}} + \alpha_{1_{i,j}}\sigma_{i,j,t} + \alpha_{2_{i,j}}\sigma_{j,t} + \alpha_{3_{i,j}}\sigma_{wd,t} \quad (11)$$

i is sector and j is country. $Contg_{i,j,t}$ is a time-series of contagion for sector i in country j at time t. $\sigma_{i,j,t}$ is the idiosyncratic volatility of sector i in country j at time t, $\sigma_{j,t}$ is the idiosyncratic volatility of country j at time t and $\sigma_{wd,t}$ is the idiosyncratic volatility of the global economy at time t.

Before discussing the channel performance results, we present the summary statistics of the time-series of contagion estimates and the idiosyncratic volatilities of the three channels in Tables (3) and (4) respectively.

[Insert Table 3 Here]

Table 3 reports descriptive statistics for the Kalman filter estimates of contagion for the contagious sectors of the sixteen sample countries (45 cases). The average contagion for every series is positive and significantly positive for all but one series. The largest average contagion is for the Chilean consumer services industry (.222) and the smallest is for the consumer goods industry in Hungary (.006). The contagious industries for Hungary tend to have more variability in their estimates of contagion while Columbia has among the lowest.

[Insert Table 4 Here]

Table 4 reports the summary statistics of idiosyncratic volatilities (reported as standard deviations in the table) of country, sector and global channels. At the country level, the average

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[11] We standardize the coefficients of equation (11) to facilitate magnitude comparisons and identification of dominant channels. In addition, coefficient significance depends on robust t statistics.

[12] To confirm that the proxies of the three channels can be simultaneously included in equation (11), we look into a potential multicollinearity problem among the independent variables. The correlation matrices of the independent variables for all the contagious sectors of 16 sample countries are reported in Table 2. We also report the variance inflation factor (VIF), an index to measure the severity of multicollineariy ***(Menard, 1995 and Neter et al, 1989)***. A VIF higher than 5 indicates possible multicollinearity among independent variables. ***(Menard, 1995 and Neter et al, 1989).*** Table 3 shows the highest VIF is 3.19, which suggests that there is not a multicollinearity problem among the independent variables in the regressions. Therefore, we can safely estimate and interpret the individual regression coefficients of equation (11).

idiosyncratic volatilities of Korea (.046) and South Africa (.049) are the largest while the two lowest are those for Malaysia (.027) and the Philippines (.030). Further, the country volatilities tend to be larger than the sector or global risks. The mean of the sector idiosyncratic volatilities ranges from .007 (Chilean utilities and Russian oil) to 0.045 (Czech Republic consumer services sector). The mean global idiosyncratic volatility is 0.02.

Channel performance is assessed based on the outcomes of equation (11). Insights may be gained by sorting the results by level of market openness or industrial classification. Sectors in an open economy are more exposed and responsive to the global economy, thus, sector effects may play a stronger role in more open economies ***(Li et al., 2004)***. The results, by degree of market openness are presented in Table 5. Table 5 also reports the R-squared for each contagious country-sector combination (45 regressions). If the R-squared is insignificantly different from 0, this particular set of channels is inappropriate for that sector. The Chinese consumer goods, Chilean healthcare, Korean industrials, and oil and gas for Thailand, South Africa and Columbia have insignificant R-squareds. Thus, we exclude these six, leaving us with 39 cases. Based on these 39 cases, Table 6 summarizes the percentage of each channel encouraging and discouraging contagion according to market openness. Investigations by industrial classification are discussed in a latter section.

[Insert Table 5 Here]

Two sectors from Panel A, one from the Czech Republic and one from Hungary, are chosen to illustrate interpretation of the results in Table 5. The Czech Republic oil and gas sector exhibits negative and significant standardized coefficients (std.) for the sector (-.2, significant at 10%), and global (-.29, significant at 5%) terms and a positive and significant coefficient for the country channel (.22, significant at 10%). Therefore, in this case, the global and sector conduits serve as channels that reduce and mitigate contagion, while the country channel risk should be a focus for the Czech Republic government because it fosters contagion. Further, we note that the global channel is a stronger mitigating force than the sector channel. In the Hungarian basic materials group, the sector channel (std. coefficient .19, significant at 10%) encourages contagion and the global channel (std. coefficient -.31, significant at 1%) discourages contagion, while the country channel is insignificant. Diversifying the sector channel risk of the basic materials sector is important for the Hungarian government, while the global channel provides a potential way to reduce contagion.

The absolute value of the estimated channel coefficients reported in Table 5 indicate that for each case (country and industry combination) the global channel has a stronger impact than the sector channel for all levels of market openness. The country channel impact is always at least as strong as the sector channel impact and the global channel is always at least as strong as the country channel. Thus, these results do not support hypothesis 2. Instead, they suggest that channel impact is not associated with market openness.

In addition, for each scenario, we examine whether the cumulative impact of the three channels is a stabilizing (coefficients sum to zero) or destabilizing force (coefficient sum is nonzero) over the official crisis period. The F test results, also included in Table 5, show that the cumulative effect of the three channels is a stabilizing force for 60% of the country-industries combinations while the impact of the channels continues into the post-crisis period for 40% of the cases.

[Insert Table 6 Here]

Table 6 summarizes Table 5 by noting the frequency (expressed in percent) that each channel encourages contagion (positive and significant channel coefficient) and discourages contagion (negative and significant channel coefficient) for various degrees of market openness. The most prominent conclusion from Table 6 is that the global channel, relative to the sector and country channels, is more likely to provide a mechanism to stabilize and mitigate contagion. When we average across all 39 cases, 62% of the contagious sectors have the global channel mitigating contagion, while the corresponding numbers for the country and sector channels are 23% and 26%. Further, the frequency of global channel mitigation increases with market openness. The above average open markets have a 67% rate of discouraged contagion through the global channel while the average and below average open markets have 57% and 56% respectively. In contrast, the country channel responses are not related to market openness and the sector channel has mixed results. The sector channel has no relationship with the degree of market openness when we focus on the role of encouraging contagion. On the other hand, if we focus on the discouraging contagion role then the frequency of the significant sector channel impact increases along with the level of market openness. Finally, these generalities need to be treated with caution due to the limited sample sizes, particularly for the above average and below average levels of openness (9 cases each).

Industry specific characteristics may play an important role in explaining the performance of the different channels ***(Phylaktis and Xia, 2006; Baur, 2012; and Bekaert et al., 2014)***. Table 7 presents the results by industrial classification and Table 8 summarizes the results of Table 7. Table 7 and Table 8 are prepared on the basis of 39 cases while Tables 1-5 use 45 cases.

[Insert Table 7 Here]

[Insert Table 8 Here]

First, from Table 7 we notice that basic materials (seven countries) and utilities (seven countries) are most often affected by contagion. Both the industrials and consumer goods sectors have six cases each while the telecommunications (one) and the technology (zero) industries have the fewest cases of contagion. The relatively unusual behavior for the telecommunications and technology industries is consistent with previous work that suggests that the technology bubble in the late 1990s has caused temporary abhorrent outcomes for these sectors ***(Phylaktis and Xia, 2006)***. When we compare the absolute magnitude of the coefficients by industry, in general the greatest impact comes from either the global or the country channel and rarely by the sector channel (only twice and both times in the oil and gas industry).

From Table 8, on a channel by channel basis, we observe that global channel is the most likely channel to be mitigating contagion (22 of 39 cases) and the country channel tends to encourage contagion (17 of 39). In an industry-by-industry comparison, we tend to see the same pattern of the global channel discouraging contagion and the country channel fostering contagion except in two situations. The oil and gas group seems to experience mitigation from the sector channel (three out of five countries) and in four out of five cases, the consumer services group shows the country channel discouraging contagion.

Finally, synthesizing Tables 5-8, we find that whether we sort by market openness or industrial classification, the global channel tends to mitigate contagion and the country channel is more likely to encourage contagion. This implies that the global channel tends to provide a stabilizing mechanism, while the country specific characteristics more likely foster contagion. Our results are consistent with the globalization hypothesis of ***Bekaert et al. (2014):*** during a crisis period, globalization tends to have a reverse effect such that the global channel provides a mitigating force.

We have identified the countries and industries with contagion and examined their response to sector, country and global transmission channels for average levels of contagion. Next, we extend our investigation by probing the channel-contagion relationship as the degree of contagion varies. Motivated by ***Baur (2013),*** we adopt a quantile regression framework to investigate this type of issue. Details are presented in Chapter 5.3.

5.3 Structure of channel performance

In Chapter 5.2, we investigated channels that encourage and discourage contagion. In Chapter 5.3, we put the issue of channel performance under a microscope. We study whether, for a given sector, a channel always fosters/mitigates contagion or if its role shifts at different degrees of contagion. We call this the structure of the channel's performance.

We follow ***Baur (2013)*** and use a quantile regression framework to investigate this issue. We select the quantile regression approach because it satisfies our interest in describing the relationship between the three channels and contagion at different degrees of contagion. Chapter 5.3.1 describes the model analyzing the structure of channel performance and Chapter 5.3.2 discusses empirical results. The mathematical description of a quantile regression is in Appendix C.

5.3.1 The model to analyze structure of channel performance

To analyze the structure of channel performance we apply quantile regression analysis to equation (11). A quantile regression approach calculates coefficients for each channel at each quantile. The sign of the coefficients determines whether the associated channel fosters or mitigates contagion.[13] If a channel always encourages (or always discourages) contagion, regardless of the quantile, this implies that the structure of the channel performance remains

[13] The quantile regression approach finds the quantile beta that minimizes the sum of weighted errors of the data within a quantile and the data point beyond that quantile. Thus, all data points are used to estimate each quantile beta, however, the data within the designated quantile receives more attention than data outside the given quantile.

unchanged, otherwise the structure of the channel performance is variable. The model is specified as follows:

$$Q(\tau)_{Contg_{i,j,t}} = \gamma_{0_{i,j}}(\tau) + \gamma_{1_{i,j}}(\tau)\sigma_{i,j,t} + \gamma_{2_{i,j}}(\tau)\sigma_{j,t} + \gamma_{3_{i,j}}(\tau)\sigma_{wd,t} + \varepsilon_t \quad (12)$$

i is sector, j is country, and τ is quantile, i.e. 5^{th} 10^{th} 15^{th} …95^{th} . $Q(\tau)$ represents the contagion in the τth quantile regression. $\gamma_{0_{i,j}}(\tau)$ is the intercept, $\gamma_{1_{i,j}}(\tau)$, $\gamma_{2_{i,j}}(\tau)$, and $\gamma_{3_{i,j}}(\tau)$ are the channel coefficients from the τth quantile regression. $\sigma_{i,j,t}$ is estimated from equation (4) and is the idiosyncratic volatility of sector i in country j at time t, $\sigma_{wd,t}$ is estimated from equation (10) and is the idiosyncratic world volatility at time t and $\sigma_{j,t}$ is estimated from equation (7) and is the idiosyncratic volatility of country j at time t.

5.3.2 Empirical results of the structure of channel performance (Hypothesis 3)

We present the empirical results of the structure of channel performance in the form of figures. In each diagram, the x-axis represents the degrees of contagion and the y-axis is the impact that each channel, $\gamma_{1_{i,j}}(\tau)$, $\gamma_{2_{i,j}}(\tau)$, and $\gamma_{3_{i,j}}(\tau)$, exerts on contagion. The results are graphed in Figure 1. We use a solid line to represent the country channel, a dashed line for the sector channel and a dotted line for the global channel. Table 9 summarizes the findings of Figure 1.

[Insert Figure 1 Here]

Structure of global channel performance:

Two examples are used to illustrate interpretation of our results. Consider the Chinese utilities sector (figure (d)), where the mitigating role of the global channel remains unchanged as the severity of contagion increases. In contrast, for the Colombian utilities sector (figure (l)), the global channel plays a diminishing role of encouraging contagion until approximately the 20^{th} quantile, and then shifts to discouraging contagion. In this case, the structure of the global channel performance changes. As we will see in the following three sections, each channel has varying scenarios for its performance structure. Below, we discuss examples for the three individual channels and then generalize.

Structure of country channel performance:

The country channel discourages contagion at all degrees of contagion for the China basic materials sector (figure (a)). In this case, the structure of the country channel's performance is stable. Further, as contagion becomes more severe, the mitigating effect becomes stronger, which means the country channel automatically stabilizes and discourages contagion as the contagion aggravates. In contrast, for the Hungarian basic materials sector (figure (q)), the country channel encourages contagion until approximately the 65th quantile, and then it shifts to mitigating contagion. This is an example of a country channel with a variable role.

Structure of sector channel performance:

In figure (e) the sector channel mitigates contagion regardless of the degree of contagion for the Chilean basic materials sector. In contrast, the Chilean oil and gas sector (figure (f)) demonstrates a sector channel that plays a diminishing role in fostering contagion and then shifts to discouraging contagion at approximately the 40th quantile illustrating a changing role for the sector channel in this scenario.

In general, for each channel there are situations where the channel's structure is consistent and situations where the structure changes. There does not seem to be any particular quantile (or severity of contagion) where the shift occurs. In addition, a channel's role tends to cluster as encouraging/discouraging before switching to discouraging/encouraging rather than jumping back and forth between types. Finally, at each quantile we tested whether the sum of the channel coefficients is zero. The results are diverse. For example, in the oil and gas sector, the sum of the channel coefficients is generally zero for Chile and Russia but non-zero for the Czech Republic and Korea. The only possible generality is for the basic materials sector where the sum of the coefficients tends to be nonzero at more severe levels of contagion regardless of country.[14] Table 9 summarizes the outcomes depicted in Figure 1.

[Insert Table 9 Here]

As Table 9 reminds us, each channel is prone to a changing structure, with the sector channel being the most volatile (69% shift) followed by the global (56%) and the country channel (54%). Nonetheless, the global channel consistently plays a mitigation role for 41% of the 39 contagious

[14] Due to the volume of the output, these results are not included but are available from the author.

sectors while it always encourages contagion in only one sector (Chilean consumer services sector). The country channel, on the other hand, encourages in 31% and discourages contagion in 15% of the cases. Finally, the sector channel discourages in 28% and fosters contagion in 3% of the scenarios.

From a micro-perspective, the results in Figure 1 do not support hypothesis 3 and instead indicate that the three channels are most likely shifting their role of encouraging and mitigating contagion as the degree of contagion varies. However, comparing across channels and the discouraging / encouraging roles, we see that a global channel is more likely to discourage (41%) and a country channel is more likely to encourage contagion (31%). This is consistent with the results presented earlier that did not segregate by quantile. The micro-perspective analysis is also consistent with the globalization hypothesis of ***Bekaert et al. (2014)***.

6. Robustness Checks

In this study, we start by identifying contagious sectors, and then estimate three potential shock transmission channels. The first check investigates the robustness of the regression specification used to detect contagious sectors and the second explores the GARCH models used to estimate the three potential channels. In Chapter 6.1, we change the measurement of the global economy from the U.S. market return (R_{UK_MK}) to the global market return (R_{World_MK}) and rerun equation (1) to detect contagion. Chapter 6.2 explores the validity of a heteroskedastic approach and the choice of asymmetric GARCH instead of the empirically popular GARCH (1, 1) model to measure idiosyncratic volatilities.

6.1 Robustness Check for Contagion Detection

In the equation (1), the U.S. market return (R_{US_MK}) is used as the control variable to proxy for the global market. We change the proxy to the global market return (R_{world_MK}) and retest hypothesis 1 using equation (14).

$$R_{i,j,t} = \beta_{0_{i,j}} + \beta_{1_{i,j}} R_{fin,j,t} + \beta_{2_{i,j}} R_{fin,j,t} * D_{crisis} + \beta_{3_{i,j}} D_{crisis} + \beta_{4_{i,j}} R_{world\_MK,t} + \varepsilon_t \qquad (14)$$

The results are presented in Table 10.

[Insert Table 10 Here]

Table 10 shows that over 95% of the outcomes are consistent with those in Chapter 5.1. Therefore, contagion detection results are robust to different global market proxies.

6.2 GARCH (1, 1) versus asymmetric GARCH (1, 1)

Choice of the optimal GARCH model is an empirical issue because the best GARCH model is sensitive to many conditions, including the sample period and size of the dataset ***(Ashley and Patterson, 2010).*** The most widely used GARCH models are GARCH (1, 1) and asymmetric GARCH (1, 1). The literature has proponents for each model. Asymmetric GARCH (1, 1) allows for asymmetries in variance and permits negative returns to exert more impact than positive returns during a market downturn. This is consistent with ***Black (1976), Christie (1982), Nelson (1991),*** and supported by ***Glosten et al. (1993), Bekaert and Harvey (1997), Bekaert et al. (2005) and Phylaktis and Xia (2009).***

However, some studies prefer a GARCH (1, 1) specification. ***Ashley and Patterson (2010)*** test the GARCH (1, 1) specification for daily stock returns from January 6, 2006 to December 31, 2007, (500 daily observations), and confirm that GARCH (1, 1) is adequate to estimate the daily return volatilities for NYSE, AMEX and the major NASDAQ stocks. ***Bali and Cakici (2008)*** investigate the idiosyncratic volatilities of cross-sectional daily and monthly data from the NYSE, AMEX, and NASDAQ of the period from July 1958 to December 2004. They favor GARCH (1, 1) because it is simple and easy to follow.

Before we can chose between GARCH (1, 1) and asymmetric GARCH (1, 1) for our dataset and our time period, we first confirm that the estimated idiosyncratic volatilities of sector, country and global models are heteroskedastic and thus that GARCH analysis is appropriate. Second, based on several metrics, we choose the model of better fit to estimate the idiosyncratic volatilities of sector, country and global models. The models are described as follows.

GARCH (1, 1): $\sigma_t^2 = a + b\sigma_{t-1}^2 + ce_{t-1}^2.$ (12)

Asymmetric GARCH (1, 1): $\sigma_t^2 = a + b\sigma_{t-1}^2 + ce_{t-1}^2 + d\eta_{t-1}^2.$ (13)

We test the adequacy of the mean and variance equations for both models by investigating the estimated standardized residuals, $\hat{z}_t = (\hat{e}_t/\hat{\sigma}_t)$ and the squared standardized residuals, $\hat{z}_t{}^2 = (\hat{e}_t/\hat{\sigma}_t)^2$ using the Ljung-Box Q-test and the Lagrange Multiplier (LM) test. $\hat{e}_t$ is the residual from the GARCH model and $\hat{\sigma}_t$ is the estimated idiosyncratic volatility. We choose the model of better fit by comparing the Akaike information criterion (AIC), Schwarz's Bayesian criterion (SBC) and log likelihood. The results are reported as follows.

For the global model:

[Insert Table 11-A Here]

Table 11-A shows that the asymmetric GARCH (1, 1) and GARCH (1, 1) models are both adequate. Asymmetric GARCH (1, 1) has a smaller AIC and SBC and a larger log likelihood, which implies that asymmetric GARCH (1, 1) provides a better fit.

For the country model:

[Insert Table 11-B Here]

Table 11-B shows that asymmetric GARCH is better than GARCH (1, 1) to estimate the idiosyncratic volatilities of the sample countries.

For the sector model:

[Insert Table 11-C Here]

Table 11-C shows that asymmetric GARCH provides a better fit than GARCH (1, 1) for over 95% of the sample sectors.

To summarize, our investigation supports the existence of heteroskedasticity. Further, based on a number of diagnostic tools, asymmetric GARCH (1, 1) is better than GARCH (1, 1) to model the idiosyncratic volatilities of sector, country and global models during the 2007- 2009 crisis. Therefore, the results in Chapter 5.2.2 use asymmetric GARCH (1, 1).

7. Conclusions and Implications

This study investigates contagion and scrutinizes the contagion transmission mechanism. We extend the existing literature by estimating a time-series of contagion for sectors identified as contagious, investigating three potential channels of shock transmission and investigating the role of the channels as the severity of contagion increases.

Our results are useful for risk management and diversification strategies. Through identifying contagious and non-contagious sectors, we find safe havens for portfolio re-balancing. For contagious sectors, we further identify the channels that foster and mitigate contagion, and this provides useful information for managing channel risks. Our main findings include:

First, among 126 studied sectors, 36% exhibit contagion. Basic materials, oil and gas, and industrials are most often identified as exhibiting contagion, while the technology sector is least affected during the crisis.

Second, we find there is no support for a relationship between the degree of market openness and the sector channel impact in our limited data set. For the countries sampled, the results do suggest that the global channel is more likely to discourage contagion relative to the other channels. Further, as markets become more open, the global channels are more likely to discourage contagion. Similarly, the sector channels likelihood of discouraging contagion increases along with market openness. There are no market openness patterns for the country channel or for any channel with respect to encouraging contagion.

Third, we also analyze channel performance by industrial classification and find that the global effects are most important, regardless of industry, in mitigating contagion. In addition, except for the consumer services sector, the country channel is the most prominent in encouraging contagion. Therefore, policies or regulations for country channel risk should be a focus in most sectors. Overall, the sector channel has less importance than the global and country channels in encouraging or discouraging contagion.

Finally, by analyzing the structure of channel performance, we observe that each of the three channels is most likely shifting the role of encouraging and mitigating contagion as contagion severity increases. However, a country channel is more likely encouraging contagion throughout and a global channel is more likely consistently mitigating contagion. To the best of our knowledge, this thesis is the first to investigate shock transmission from a micro-perspective.

8. Limitations and Recommendations for Future Studies

Despite the contributions mentioned above, there are limitations in our study. First, the contagion time path for each series and each of the volatility measures is unobserved and must be estimated.

Although we have done a careful and thorough job, there is still measurement error in the estimates. Second, we find that the three potential channels of contagion transmission are not appropriate for six sectors within our sample. Therefore, investigating other possible contagion channels is important for future studies. Third, a broader sample of countries may provide interesting comparisons and allow for statistical testing when, for example assessing the role of market openness. Fourth, we employ quantile to represent different degrees of contagion and we examine channel performance at various contagion levels. It would be interesting to study how the channel performance responds to varying degrees of crisis severity. Finally, our study focuses on explaining channel performance by market openness and industrial classification. Future studies may analyze results from other perspectives, such as, trade and finance linkages, domestic macroeconomic fundamentals and corporate governance characteristics.

APPENDIX A: DATASTREAM INDICES (SECTOR AND INDUSTRY CLASSIFICATION)

SECTOR	INDUSTRIES INCLUDED	SECTOR	INDUSTRIES INCLUDED	SECTOR	INDUSTRIES INCLUDED
Oil&Gas	Exploration&Production	**Consumer Goods**	Automobiles	**Consumer Services**	Drug Retailers
	Integrated Oil&Gas		Auto Parts		Food Retailers & Wholesalers
	Oil Equipment & Services		Tires		Apparel Retailers
	Pipelines		Brewers		Broadline Retailers
	Renewable Energy Equipment		Distillers & Vintners		Home Improvement Retailers
	Alternative Fuels		Soft Drinks		Specialized Consumer Services
Basic Materials	Commodity Chemicals		Farming & Fishing		Specialty Retailers
	Specialty Chemicals		Food Products		Broadcasting & Entertainment
	Forestry		Durable Household Products		Media Agencies
	Aluminum		Nondurable Household Products		Publishing
	Nonferrous Metals		Furnishings		Airlines
	Iron&Steel		Home Construction		Gambling
	Coal		Consumer Electronics		Hotels
	Diamonds&Gemstones		Recreational Products		Recreational Services
	General Mining		Toys		Restaurants & Bars
	Platinum&Precious Metals		Clothing & Accessories		Travel & Tourism
Industrials	Building Materials&Fixtures		Footwear	**Financials**	Banks
	Heavy Construction		Personal Products		Full Line Insurance
	Aerospace		Tobacco		Insurance Brokers
	Defense	**Healthcare**	Healthcare Providers		Property & Casualty Insurance
	Containers & Packaging		Medical Equipment		Reinsurance
	Diversified Industrials		Medical Supplies		Real Estate Holding & Development
	Electrical Components &Equipment		Biotechnology		Real Estate Services
	Electronic Equipment		Pharmaceuticals		Industrial & Office REITs
	Commercial Vehicles & Trucks	**Telecommuni cations**	Fixed Line Telecommunications		Retail REITs
	Industrial Machinery		Mobile Telecommunications		Residential REITs
	Delivery Services	**Utilities**	Conventional Electricity		Diversified REITs
	Marine Transportation		Alternative Energy		Specialty REITs
	Railroads		Gas Distribution		Mortgage REITs
	Transportation Services		Multiutilities		Hotel & Lodging REITs
	Trucking		Water		Asset Managers
	Business Support Services	**Technology**	Computer Services		Consumer Finance
	Business Training & Employment Agencies		Internet		Specialty Finance
	Financial Administration		Software		Investment Services
	Industrial Suppliers		Computer Hardware		Mortgage Finance
	Waste & Disposal Services		Electronic Office Equipment		Equity Investment Instruments
			Semiconductors		Nonequity Investment Instruments
			Telecommunications Equipment		

APPENDIX B: EQUATIONS OF THE KALMAN FILTER

$R_{i,j,t} = \beta_{0_{i,j}} + \beta_{1_{i,j}} R_{fin,j,t} + \beta_{2_{i,j}} R_{fin,j,t} * D_{crisis,t} + \beta_{3_{i,j}} D_{crisis,t} + \beta_{4_{i,j}} R_{US_{MK},t} + \varepsilon_t$ *Measurement Equation*

$\beta_{2_{i,j,t+1}} = F * \beta_{2_{i,j,t}} + W_t + n_t$ *Transition Equation*

Where $R_{fin,j,t}, R_{fin,j,t}, D_{crisis,t}$ *and* $R_{US_{MK},t}$ are observed.

$\beta_{2_{i,j}} \sim \left(E\left(\beta_{2_{i,j}}\right), P\right);\ \varepsilon \sim (0, h); n \sim (0, q); E(\varepsilon, n) = 0$

$\beta_{2_{i,j,t}}$ is the unobserved state vector that is time varying. F is the transition matrix (in this case a scalar)

W=potential exogenous variables. Without loss of generality, let $W=0$.

To start the process, get initial values for β_2 $(= \beta_{1|0}), P(=P_{1|0}), \sigma_e^2 = (\sigma_{e\ 1|0}^2) = h$ (where σ_e^2 is the variance of the residuals from the measurement equation estimated over the full period), and estimate q = *(signal to noise)* * h, then calculate:

Recursion 1:

$v_1 = r_1 - r_{1|0}$ *Where* $r_{1|0} = \hat{\alpha} + R_{M,1}\beta_{1|0}$

$Gain_{1|0} = (P_{1|0} R_{M,1})/(P_{1|0} R^2_{M,1} + h) \approx Cov_{1|0}(\beta, v)/Var_{1|0}(v)$

$\beta_{2|1} = \beta_{1|0} + Gain_{1|0} * v_1$

$P_{2|1} = P_{1|0} - (P_{1|0} R_{M,1})/(P_{1|0} R^2_{M,1} + h)\, R_{M,1} P_{1|0} + q = P_{1|0} - Gain_{1|0} R_{M,1} P_{1|0} + q$

Recursion t:

$R_{t|t-1} = \hat{\alpha} + R_{M,t}\beta_{t|t-1}$

$v_t = r_t - r_{t|t-1}$

$Gain_{t|t-1} = (P_{t|t-1} R_{M,t})/(P_{t|t-1} R^2_{M,t} + h)\ \beta_{t+1|t} = \beta_{t|t-1} + Gain_{t|t-1} * v_t$ *Updating equations for* β_2

$P_{t+1|t} = P_{t|t-1} - Gain_{t|t-1} R_{M,t} P_{t|t-1} + q$ *Updating equations for* $V(\beta_2)$

APPENDIX C: QUANTILE REGRESSION

We describe quantile regression by starting from linear regression.

A generic model for linear regression is:

$y = X'\beta + \varepsilon$

Where $X' = (x_1, \dots, x_n)'$ is the $(n \times p)$ regressor matrix, $\beta = (\beta_1, \dots, \beta_p)'$is the $(p \times 1)$vector of unknown parameter, and $\varepsilon = (\varepsilon_1, \dots, \varepsilon_n)'$is the $(n \times 1)$vector of unknown errors.

The ordinary least squares estimate of the relationship between Y and X is given by: $\hat{\beta}^{OLS} = minimize \sum_{t=1}^{T}(Y_t - X'\hat{\beta})^2 = minimize \sum_{t=1}^{T}(e_t)^2$.

In a quantile regression framework,

$Q_y(\tau|x) = X'\beta$ +ε

Where $Q_y(\tau|x)$is the conditional quantile of y at τ. τ = 5th, 10th,15th…95th quantile.

$Q_y(\tau|x)$ is assumed to be linearly dependent on x and $\beta(\tau)$ determines that linear dependency (***Koenker, 2001; Koenker et al., 1978***).

$\hat{\beta}(\tau) = minimize\ \sum_{Y\ within\ quantile\ \tau} \tau \left|Y - X'\hat{\beta}(\tau)\right| + \sum_{Y is\ outside\ qantile\ \tau}(1-\tau)\left|Y - X'\hat{\beta}(\tau)\right|$

The mathematical description of quantile regression, as presented below, follows ***Baur (2013).***

$\widehat{Q_y}(\tau) = \widehat{F_y^{-1}}(\tau) = \inf\{a|\widehat{F_y}(a) \geq \tau\}$

Assuming that y is linearly dependent on a vector of exogenous variables x, the linear conditional quantile function can be written as,

$Q_y(\tau|x) = \inf\left\{a\middle|F_y(a) \geq \tau\right\} = \sum_k \beta_k(\tau)\, x_k = x'\beta(\tau)$

The quantile regression coefficients are obtained by solving with respect to $\beta(\tau)$:

$\hat{\beta}(\tau) = argmin_{\beta(\tau)\in R}\left\{\sum_{i:y_i \geq x'\beta(\tau)} \tau|y_i - x_i{}'\beta(\tau)| + \sum_{i:y_i \leq x'\beta(\tau)}(1-\tau)|y_i - x_i{}'\beta(\tau)|\right\}$

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TABLES

Table 1: Contagion Detection

Detect contagion by estimating $equation(1)$: $R_{i,j,t} = \beta_{0_{i,j}} + \beta_{1_{i,j}} R_{fin,j,t} + \beta_{2_{i,j}} R_{fin,j,t} * D_{crisis,t} + \beta_{3_{i,j}} D_{crisis,t} + \beta_{4_{i,j}} R_{US_{MK},t} + \varepsilon_t$ (i is sector, j is country and t is time). The table reports the estimated $\beta_{2_{i,j}}$. If there is contagion, $\beta_{2_{i,j}}$ is positive and significant. Otherwise, there is no contagion. $R_{i,j,t}$ is the return of an individual industry index i in country j ; $R_{fin,j,t}$ is the financial sector return of country j; $R_{US_{MK},t}$ is the return of US market; $D_{crisis,t}$ is the crisis dummy. The pre-crisis period is from Nov. 2001 to Aug. 2007, totaling 305 weeks, and the crisis period is from Sept. 2007 to June 2009, totaling 95 weeks. Within the crisis period, $D_{crisis,t} = 1$, otherwise $D_{crisis,t} = 0$. Industry names are abbreviated as follows: Oil and gas (OIL), basic materials (BM), industrials (IND), consumer goods (CNS), health care (HL), consumer services (CN), telecommunications (TEL), utilities (UT), financials (FIN), technology (TEC), and the total market return is denoted MKT. For ease of exposition, the results are in Panels A-B. ***, **, and * indicate, respectively, significance at the 1%, 5%, and 10% levels.

Panel A

Country / *Sector*	***Brazil***	***China***	***Chile***	***Colombia***	***Czech Republic(CZ)***	***Greece***	***Hungary***	***India***
OIL	-0.45342***	0.04036	0.21611***	0.74141***	0.40447***	-0.05496	0.24074***	0.00986
BM	-0.35963***	0.17935***	0.22121***	-0.1994***	-0.31038***	-0.02335	0.18911***	-0.01389
IND	-0.53854***	0.17533***	0.23392***	-0.02433	-0.01869	-0.23832***	0.07448	0.07224*
CNS	-0.44122***	0.06274*	0.07979**	-0.04612	0.13394***	-0.23909***	0.02975	-0.18315***
HL		0.00365	0.3986***		-0.31015***		0.25409***	-0.09147***
CN		0.1769***	0.27915***	0.14445**	0.3726***	-0.16107***	0.08387*	-0.08296**
TEL	-0.58849***	-0.00877	-0.1083**		-0.12115***	-0.06429*	0.05981*	0.02227
UT	-0.88081***	0.07606*	0.06845*	0.18807***	0.01904	0.02582	0.37605***	-0.06903**
TEC		0.04659			-0.02454	-0.50463***	-0.11071***	-0.07727**

Table 1: Panel B

Sector \ Country	*Korea*	*Malaysia*	*Philippines*	*Poland*	*Russia*	*South Africa*	*Thailand*	*Turkey*
OIL	0.22138***	0.02264	-0.38451***	-0.14276***	0.20063***	0.26887***	0.41124***	-0.02557
BM	0.12536**	0.06624	-0.08386	0.02331	0.11465**	0.06822	0.29841***	0.17116***
IND	0.14524***	0.11911***	0.04095	0.16019***		-0.04937*	0.1403***	-0.04440***
CNS	-0.13100***	0.16338***	0.25543***	0.11853*		-0.04881	0.18935***	-0.11685***
HL	-0.04475	-0.05734				-0.04444*	0.09053**	-0.20788***
CN	-0.00169	0.03056	0.06395	-0.09944***	-0.03285	0.00102	-0.01201	-0.22143***
TEL	-0.11230***	-0.04130	-0.06920*	-0.25683***	0.00454	0.01385	-0.18261***	-0.15983***
UT	0.38417***	0.0994*	-0.06930	-0.00552	0.14903***		0.01694	-0.02031
TEC	-0.13080***			-0.16798***			-0.32414***	0.04454

Table 2: Correlation Matrix and Variation Inflation Factor (VIF) for the Independent Variables of Equation (11)

This table presents the correlation matrix as well as theVIF for the independent variables of $equation(11)$, $Contg_{i,j,t} = \alpha_{0_{i,j}} + \alpha_{1_{i,j}}\sigma_{i,j,t} + \alpha_{2_{i,j}}\sigma_{wd,t} + \alpha_{3_{i,j}}\sigma_{j,t}$ (i is sector, j is country and t is time period. $Contg_{i,j,t}$ is the contagion magnitude of sector i in country j at time t. $\sigma_{i,j,t}$ is the idiosyncratic volatility of sector i in country j at time t. $\sigma_{j,t}$ is the idiosyncratic volatility of country j at time t. $\sigma_{wd,t}$ is the idiosyncratic volatility of the world at time t). $\sigma_{i,j,t}$, $\sigma_{j,t}$ and $\sigma_{wd,t}$ each have 95 observations and are estimated from sector, country and global GARCH models. $Contg_{i,j,t}$ has 95 observations and is estimated using the Kalman Filter. Industry abbreviations are as follows: Oil and gas (OIL), basic materials (BM), industrials (IND), consumer goods (CNS), health care (HL), consumer services (CN), telecommunications (TEL), utilities (UT), financials (FIN), and technology (TEC). Other abbreviations: Total market return (MKT), *Idio.MKT* represents idiosyncratic volatility (std.dev) of country, *Idio.GLOBE* is the idiosyncratic volatility (std.dev) of global and *Idio.(sector i)* is the idiosyncratic volatilities (std.dev) of sector i. For ease of exposition, the results are in Panels A-C. CZ stands for Czech Republic.

Panel A

Chile				
	Idio.MKT	Idio.OIL	Idio.GLOBE	VIF
Idio.MKT	1			1.42774
Idio.OIL	-0.00559	1		1.0284
Idio.GLOBE	0.54143	0.13662	1	1.45485
	Idio.MKT	Idio.BM	Idio.GLOBE	VIF
Idio.MKT	1			1.42195
Idio.BM	0.11761	1		1.01677
Idio.GLOBE	0.54143	0.10706	1	1.41854
	Idio.MKT	Idio.IND	Idio.GLOBE	VIF
Idio.MKT	1			1.50299
Idio.IND	0.29272	1		1.09393
Idio.GLOBE	0.54143	0.16976	1	1.41499
	Idio.MKT	Idio.CNS	Idio.GLOBE	VIF
Idio.MKT	1			1.41471
Idio.CNS	0.09534	1		1.03142
Idio.GLOBE	0.54143	0.17454	1	1.4459
	Idio.MKT	Idio.HL	Idio.GLOBE	VIF
Idio.MKT	1			1.42985
Idio.HL	0.2587	1		1.13155
Idio.GLOBE	0.54143	0.3268	1	1.49368

China				
	Idio.MKT	Idio.BM	Idio.GLOBE	VIF
Idio.MKT	1			1.03971
Idio.BM	0.17981	1		1.09416
Idio.GLOBE	0.11936	0.2516	1	1.07409
	Idio.MKT	Idio.IND	Idio.GLOBE	VIF
Idio.MKT	1			1.01446
Idio.IND	0.00886	1		1.00336
Idio.GLOBE	0.11936	0.05784	1	1.01778
	Idio.MKT	Idio.CNS	Idio.GLOBE	VIF
Idio.MKT	1			1.01445
Idio.CNS	0.00684	1		1.00291
Idio.GLOBE	0.11936	0.05382	1	1.01735
	Idio.MKT	Idio.CN	Idio.GLOBE	VIF
Idio.MKT	1			1.05989
Idio.CN	0.1988	1		1.04788
Idio.GLOBE	0.11936	-0.05427	1	1.02101
	Idio.MKT	Idio.UT	Idio.GLOBE	VIF
Idio.MKT	1			1.02435
Idio.UT	0.01915	1		1.00976
Idio.GLOBE	0.11936	-0.02765	1	1.01459

Colombia				
	Idio.MKT	Idio.OIL	Idio.GLOBE	VIF
Idio.MKT	1			3.19715
Idio.OIL	0.78252	1		2.69745
Idio.GLOBE	0.45131	0.23698	1	1.31318
	Idio.MKT	Idio.HL	Idio.GLOBE	VIF
Idio.MKT	1			1.25892
Idio.HL	0.06796	1		1.01684
Idio.GLOBE	0.45131	-0.15885	1	1.27681
	Idio.MKT	Idio.CNS	Idio.GLOBE	VIF
Idio.MKT	1			1.28814
Idio.CNS	-0.0093	1		1.05232
Idio.GLOBE	0.45131	-0.11873	1	1.31538
	Idio.MKT	Idio.UT	Idio.GLOBE	VIF
Idio.MKT	1			1.28842
Idio.UT	0.12214	1		1.02797
Idio.GLOBE	0.45131	-0.04381	1	1.27164
Philippines				
	Idio.MKT	Idio.CNS	Idio.GLOBE	VIF
Idio.MKT	1			1.1775

Table 2: Panel A-Continued

	Idio.MKT	Idio.CN	Idio.GLOBE	VIF
Idio.MKT	1			1.49931
Idio.CN	0.26765	1		1.0776
Idio.GLOBE	0.54143	0.12855	1	1.41529

	Idio.MKT	Idio.UT	Idio.GLOBE	VIF
Idio.MKT	1			1.41472
Idio.UT	0.00214	1		1.00001
Idio.GLOBE	0.54143	-0.00031	1	1.41472

India				
	Idio.MKT	Idio.IND	Idio.GLOBE	VIF
Idio.MKT	1			1.2855
Idio.IND	0.2242	1		1.05403
Idio.GLOBE	0.42874	0.06766	1	1.2265

Idio.CNS	0.13349	1		1.0314
Idio.GLOBE	0.38085	0.15474	1	1.18489

Table 2: Panel B

CZ

	Idio.MKT	Idio.TEC	Idio.GLOBE	VIF
Idio.MKT	1			1.25797
Idio.TEC	-0.04693	1		1.00221
Idio.GLOBE	0.45131	-0.02139	1	1.25577

	Idio.MKT	Idio.OIL	Idio.GLOBE	VIF
Idio.MKT	1			2.17924
Idio.OIL	0.43287	1		1.44597
Idio.GLOBE	0.73497	0.55407	1	2.55537

	Idio.MKT	Idio.CNS	Idio.GLOBE	VIF
Idio.MKT	1			2.18056
Idio.CNS	0.00281	1		1.00534
Idio.GLOBE	0.73497	0.05145	1	2.18633

	Idio.MKT	Idio.CN	Idio.GLOBE	VIF
Idio.MKT	1			2.39055
Idio.CN	0.52602	1		1.41293
Idio.GLOBE	0.73497	0.47119	1	2.22255

Poland

	Idio.MKT	Idio.IND	Idio.GLOBE	VIF
Idio.MKT	1			1.90858
Idio.IND	-0.03698	1		1.01414
Idio.GLOBE	0.6858	0.05625	1	1.91202

	Idio.MKT	Idio.CNS	Idio.GLOBE	VIF
Idio.MKT	1			1.89264
Idio.CNS	-0.01438	1		1.00351
Idio.GLOBE	0.6858	0.03189	1	1.89418

	Idio.MKT	Idio.HL	Idio.GLOBE	VIF
Idio.MKT	1			1.89421
Idio.HL	0.06726	1		1.0047
Idio.GLOBE	0.6858	0.03709	1	1.88823

South Africa

	Idio.MKT	Idio.OIL	Idio.GLOBE	VIF
Idio.MKT	1			1.82808
Idio.OIL	0.14819	1		1.07352
Idio.GLOBE	0.67249	0.2593	1	1.91681

	Idio.MKT	Idio.BM	Idio.GLOBE	VIF
Idio.MKT	1			1.82634
Idio.BM	0.16643	1		1.05436
Idio.GLOBE	0.67249	0.22625	1	1.87156

Korea

	Idio.MKT	Idio.OIL	Idio.GLOBE	VIF
Idio.MKT	1			1.01332
Idio.OIL	0.08398	1		1.03044
Idio.GLOBE	0.06514	-0.14417	1	1.02753

	Idio.MKT	Idio.BM	Idio.GLOBE	VIF
Idio.MKT	1			1.00764
Idio.BM	-0.05738	1		1.00341
Idio.GLOBE	0.06514	0.00649	1	1.00437

	Idio.MKT	Idio.IND	Idio.GLOBE	VIF
Idio.MKT	1			1.01405
Idio.IND	0.10227	1		1.01453
Idio.GLOBE	0.06514	0.06872	1	1.0082

	Idio.MKT	Idio.UT	Idio.GLOBE	VIF
Idio.MKT	1			1.04214
Idio.UT	-0.18648	1		1.04072
Idio.GLOBE	0.06514	0.05368	1	1.00881

Table 2: Panel C

Malaysia				
	Idio.MKT	Idio.IND	Idio.GLOBE	VIF
Idio.MKT	1			2.29306
Idio.IND	0.75072	1		2.29499
Idio.GLOBE	0.00407	0.02929	1	1.0016
	Idio.MKT	Idio.CNS	Idio.GLOBE	VIF
Idio.MKT	1			1.00065
Idio.CNS	0.02538	1		1.07727
Idio.GLOBE	0.00407	0.26672	1	1.0766
	Idio.MKT	Idio.UT	Idio.GLOBE	VIF
Idio.MKT	1			1.34659
Idio.UT	0.50726	1		1.34667
Idio.GLOBE	0.00407	-0.00847	1	1.00017
Russia				
	Idio.MKT	Idio.OIL	Idio.GLOBE	VIF
Idio.MKT	1			1.61853
Idio.OIL	0.42973	1		1.29306
Idio.GLOBE	0.58312	0.41702	1	1.59745
	Idio.MKT	Idio.BM	Idio.GLOBE	VIF
Idio.MKT	1			1.64712
Idio.BM	0.33313	1		1.12504
Idio.GLOBE	0.58312	0.18375	1	1.5155
	Idio.MKT	Idio.UT	Idio.GLOBE	VIF
Idio.MKT	1			2.55613
Idio.UT	0.65513	1		1.8161
Idio.GLOBE	0.58312	0.26664	1	1.57072

Hungary				
	Idio.MKT	Idio.OIL	Idio.GLOBE	VIF
Idio.MKT	1			1.44534
Idio.OIL	0.08823	1		1.03355
Idio.GLOBE	0.55496	0.17964	1	1.48191
	Idio.MKT	Idio.BM	Idio.GLOBE	VIF
Idio.MKT	1			1.4466
Idio.BM	0.05126	1		1.02135
Idio.GLOBE	0.55496	0.14091	1	1.47203
	Idio.MKT	Idio.HL	Idio.GLOBE	VIF
Idio.MKT	1			1.45019
Idio.HL	0.00561	1		1.01346
Idio.GLOBE	0.55496	0.09885	1	1.46445
	Idio.MKT	Idio.CN	Idio.GLOBE	VIF
Idio.MKT	1			1.44628
Idio.CN	0.06513	1		1.00633
Idio.GLOBE	0.55496	0.07382	1	1.44804
	Idio.MKT	Idio.TEL	Idio.GLOBE	VIF
Idio.MKT	1			1.46279
Idio.TEL	0.12581	1		1.01617
Idio.GLOBE	0.55496	0.06193	1	1.44519
	Idio.MKT	Idio.UT	Idio.GLOBE	
Idio.MKT	1			VIF
Idio.UT	0.02984	1		1.48253
Idio.GLOBE	0.55496	0.28239	1	1.11483
				1.60956

Thailand				
	Idio.MKT	Idio.OIL	Idio.GLOBE	VIF
Idio.MKT	1			1.16351
Idio.OIL	0.27051	1		1.12241
Idio.GLOBE	0.32223	0.26649	1	1.1608
	Idio.MKT	Idio.BM	Idio.GLOBE	VIF
Idio.MKT	1			1.37882
Idio.BM	0.50764	1		1.46953
Idio.GLOBE	0.32223	0.39893	1	1.21721
	Idio.MKT	Idio.IND	Idio.GLOBE	VIF
Idio.MKT	1			1.27817
Idio.IND	0.36942	1		1.15832
Idio.GLOBE	0.32223	0.10538	1	1.11613
	Idio.MKT	Idio.CNS	Idio.GLOBE	VIF
Idio.MKT	1			1.13387
Idio.CNS	0.18884	1		1.07048
Idio.GLOBE	0.32223	0.22532	1	1.15191
	Idio.MKT	Idio.HL	Idio.GLOBE	VIF
Idio.MKT	1			1.11591
Idio.HL	0.02758	1		1.00452
Idio.GLOBE	0.32223	0.06678	1	1.12005
Turkey				
	MKTTHAI	BMATRTH	Idio.GLOBE	VIF
MKTTHAI	1			1.07776
BMATRTH	0.24101	1		1.06195
Idio.GLOBE	0.12185	0.01365	1	1.01534

Table 3: Descriptive Statistics for the Kalman Filter Time-series Estimates of Contagion

This table reports the summary statistics of the contagion (contg) series estimated by the Kalman filter. Each series includes 95 observations. Industry classifications are abbreviated as follows: Oil and gas (OIL), basic materials (BM), industrials (IND), consumer goods (CNS), health care (HL), consumer services (CN), telecommunications (TEL), utilities (UT), financials (FIN), technology (TEC). CZ stands for Czech Republic.

Sectors	*Mean*	*Std Dev*	*t Value*	*Minimum*	*Maximum*	*Sectors*	*Mean*	*Std Dev*	*t Value*	*Minimum*	*Maximum*
Chile_contg_OIL	0.135	0.026	50.720	0.101	0.179	*Korea_contg_oil*	0.140	0.020	67.430	0.091	0.180
Chile_contg_BM	0.180	0.003	532.420	0.168	0.193	*Korea_contg_BM*	0.157	0.024	63.140	0.117	0.198
Chile_contg_IN	0.179	0.010	176.150	0.160	0.196	*Korea_contg_IN*	0.185	0.013	136.220	0.166	0.215
Chile_contg_CNS	0.175	0.018	92.970	0.146	0.200	*Korea_contg_UT*	0.129	0.022	57.140	0.077	0.180
Chile_contg_HL	0.184	0.011	164.430	0.160	0.207	*Turkey_contg_BM*	0.171	0.021	78.880	0.122	0.201
Chile_contg_CN	0.222	0.022	99.540	0.180	0.253	*Malaysia_contg_IN*	0.181	0.014	128.520	0.152	0.204
Chile_contg_UT	0.180	0.005	321.420	0.171	0.196	*Malaysia_contg_CNS*	0.178	0.007	246.240	0.162	0.188
China_contg_BM	0.171	0.010	171.490	0.147	0.190	*Malaysia_contg_UT*	0.160	0.020	76.790	0.124	0.189
China_contg_IN	0.153	0.012	129.450	0.131	0.184	*Philippines_contg_CNS*	0.109	0.035	30.460	0.054	0.179
China_contg_CNS	0.122	0.017	70.630	0.097	0.180	*Poland_contg_IN*	0.147	0.022	64.360	0.114	0.185
China_contg_CN	0.159	0.013	120.870	0.131	0.181	*Poland_contg_CNS*	0.057	0.059	9.430	-0.029	0.182
China_contg_UT	0.136	0.022	59.430	0.102	0.184	*Russia_contg_OIL*	0.057	0.059	9.430	-0.029	0.182
India_contg_IN	0.135	0.026	50.720	0.101	0.179	*Russia_contg_BM*	0.135	0.047	28.310	0.059	0.200
Colombia_contg_OIL	0.180	0.003	532.420	0.168	0.193	*Russia_contg_UT*	0.068	0.043	15.160	0.001	0.179
Colombia_contg_CN	0.189	0.006	296.320	0.177	0.201	*SouthAfrica_contg_OIL*	0.068	0.043	15.160	0.001	0.179
Colombia_contg_TEC	0.164	0.011	145.980	0.149	0.182	*Thailand_contg_OIL*	0.068	0.043	15.160	0.001	0.179
CZ_contg_OIL	0.164	0.011	145.980	0.149	0.182	*Thailand_contg_BM*	0.193	0.029	65.200	0.143	0.243
CZ_contg_CNS	0.006	0.095	0.660	-0.121	0.177	*Thailand_contg_IN*	0.141	0.022	63.820	0.112	0.179
CZ_contg_CN	0.085	0.055	15.220	-0.041	0.177	*Thailand_contg_CNS*	0.172	0.008	216.430	0.153	0.193
Hungary_contg_OIL	0.085	0.055	15.220	-0.041	0.177	*Thailand_contg_HL*	0.087	0.065	13.030	-0.002	0.180
Hungary_contg_BM	0.086	0.062	13.530	-0.012	0.179						
Hungary_contg_HL	0.078	0.054	14.100	0.000	0.179						
Hungary_contg_CN	0.068	0.058	11.440	-0.018	0.180						
Hungary_contg_TEL	0.023	0.087	2.570	-0.123	0.179						
Hungary_contg_UT	0.140	0.020	67.430	0.091	0.180						

Table 4: Summary Statistics of Idiosyncratic Volatilities of Sector, Country and Global Models

This table presents the statistics of idiosyncratic volatilities of the world, *16* sample countries, and a maximum possible 9 sectors per country. The sector idiosyncratic volatility is estimated from the sector model: *Equation (2)* $r_{i,j,t} = \boldsymbol{\delta_{i,j}}'\boldsymbol{X_{i,j,t-1}} + \omega^{j}_{i,j,t-1}\mu_{j.t-1} + \omega^{j}_{i,j,t-1}e_{j,t} + e_{i,j,t}$ (vector $\boldsymbol{X_{i,j,t-1}}$ contains a set of local economic information variables, estimating the expected return of sector i, which include a constant, lagged sector return and market dividend yield. $r_{i,j,t}$ is the return of sector i in country *j* in excess of the home country's 3-month T-bill rate. The expected returns on the market of country *j in* excess of the home country's 3-month T-bill rate, conditional on information available at time $t-1$, is $\mu_{j,t-1}$. Market expected returns at time t for country *j* are measured by taking the average of market returns from time 1 to time $t-1$. The residual of market excess return of country *j* is $e_{j,t}$. All the excess returns are expressed in US dollars).We save the residuals ($e_{i,j,t}$) of *Equation (2)*, which are conditional on all the information available at time t -1 (Ω_{t-1}) and use asymmetric GARCH, *equation(4)*, $\sigma^2_{i,j,t} = a_{i,j} + b_{i,j}\sigma^2_{i,j,t-1} + c_{i,j}e^2_{i,j,t-1} + d_{i,j}\eta^2_{i,j,t-1}$,to model the volatilities of the residuals. $\eta_{i,j,t}$ captures the asymmetric and negative information of sector i and $\eta_{i,j,t} = \min(0, e_{i,j,t})$.The country idiosyncratic volatility is estimated from the country model *Equation (5):* $r_{j,t} = \boldsymbol{\delta_{j,t}}'\boldsymbol{X_{j,t-1}} + \omega^{w}_{i,j,t-1}\mu_{w,t-1} + \omega^{w}_{i,j,t-1}e_{w,t} + e_{j,t}$ (where $r_{j,t}$ is the daily return of country *j* in excess of the home country's 3-month T-bill rate. The information set of country*j* is $X_{j,t-1}$, the expected return on the global market in excess of the home country's 3-month T-bill rate, conditional on information available at time $t-1$, is $\mu_{w,t-1}$. Global market expected returns at time t are measured by taking the average of global market returns from time 1 to time $t-1$. The residual of the excess expected return from the global market is $e_{w,t}$. The fundamentals include a constant, market dividend yield and the lagged exchange rate).We save the residuals of *Equation (5)*, which are conditional on all the information available at time t -1 (Ω_{t-1}). These residuals are modeled according to an asymmetric GARCH process, see equation *(7)*: $\sigma^2_{j,t} = a_j + b_j\sigma^2_{j,t-1} + c_je^2_{j,t-1} + d_j\eta^2_{j,t-1}$, . $\eta_{i,t}$ captures the asymmetric and negative information of the country market and $\eta_{i,t} = \min(0, e_{j,t})$. The global idiosyncratic volatility is estimated from the global mode, *Equation(8):* $r_{wd,t} = \boldsymbol{\delta_{wd,t}}'\boldsymbol{X_{wd,t-1}} + e_{wd,t}$ ($r_{wd,t}$ is the excess return of world return, vector $\boldsymbol{X_{wd,t-1}}$ is a set of world information variables including a constant, world market dividend yield, the default spread (Moody's Baa minus Aaa bond yields), the change in the term structure spread (US 10-year bond yield minus 3-month US T-bill rate), and the change in the 30-day Eurodollar rate).We save the residual of *Equation (8)*, which is conditional on all the information available at time t -1 (Ω_{t-1}) and model it using Equation (10): $\sigma^2_{wd,t} = a_{wd} + b_{wd}\sigma^2_{wd,t-1} + c_{wd}e^2_{wd,t-1} + d_{wd}\eta^2_{wd,t-1}$. Each idiosyncratic volatility series includes 95 observations. The following naming conventions are used: Oil and gas (OIL), basic materials (BM), industrials (IND), consumer goods (CNS), health care (HL), consumer services (CN), telecommunications (TEL), utilities (UT), financials (FIN), technology (TEC), total market return (MKT), *(country j)_Idio.MKT* represents idiosyncratic volatility (std.dev) of country j, *Idio.GLOBE* is the idiosyncratic volatility (std.dev) of global and *(country j)_Idio.(sector i)* is idiosyncratic volatility of the sector i of country j. CZ stands for Czech Republic.

Table 4: Summary Statistics of Idiosyncratic Volatilities of Sector, Country and Global Models

Variable	*Mean*	*Std Dev*	*Skewness*	*Kurtosis*	*Minimum*	*Maximum*	*Variable*	*Mean*	*Std Dev*	*Skewness*	*Kurtosis*	*Minimum*	*Maximum*
Chile_Idio.MKT	0.031	0.0202	1.17424	0.8278	0.00801	0.09213	*Korea_Idio.MKT*	0.046	0.0319	1.6609	2.7762	0.01358	0.16174
Chile_Idio.OIL	0.016	0.0129	2.52347	6.7916	0.00702	0.07469	*Korea_Idio.OIL*	0.025	0.0145	2.17178	4.8047	0.01366	0.08154
Chile_Idio.BM	0.011	0.013	4.72588	27.754	0.00491	0.10194	*Korea_Idio.BM*	0.018	0.014	3.27056	11.982	0.01002	0.09322
Chile_Idio.IND	0.013	0.0132	4.12276	23.865	0.00524	0.10437	*Korea_Idio.IND*	0.019	0.0166	2.26896	4.744	0.00838	0.07999
Chile_Idio.CNS	0.012	0.01	2.96722	11.389	0.00584	0.06835	*Korea_Idio.UT*	0.021	0.0178	3.57632	15.41	0.0114	0.12214
Chile_Idio.HL	0.02	0.0147	3.8303	17.981	0.01202	0.10512	*Malaysia_Idio.MKT*	0.027	0.0213	4.3493	30.24	0.00672	0.18362
Chile_Idio.UT	0.007	0.0042	2.15493	4.7132	0.00402	0.02503	*Malaysia_Idio.IND*	0.011	0.0106	4.4271	26.873	0.00586	0.08643
China_Idio.MKT	0.041	0.0348	1.67578	1.9016	0.01526	0.1619	*Malaysia_Idio.CNS*	0.012	0.0074	2.36069	6.01	0.00702	0.04652
China_Idio.BM	0.015	0.014	2.07099	4.1199	0.00444	0.06957	*Malaysia_Idio.UT*	0.011	0.0112	3.15021	11.011	0.00542	0.06798
China_Idio.IND	0.012	0.0093	2.4114	5.9635	0.00635	0.05398	*Philippines_Idio.MKT*	0.03	0.027	3.32294	16.02	0.0107	0.19792
China_Idio.CNS	0.017	0.0157	2.86403	9.9379	0.0056	0.10124	*Philippines_Idio.CNS*	0.015	0.0105	4.67021	30.308	0.00981	0.0924
China_Idio.CN	0.019	0.0161	2.02285	4.6968	0.00624	0.08794	*Poland_Idio.MKT*	0.042	0.0342	2.36611	6.7616	0.01455	0.20522
China_Idio.UT	0.029	0.0154	2.81571	9.6037	0.01808	0.10975	*Poland_Idio.IND*	0.02	0.0123	2.43997	8.0885	0.01085	0.08309
India_Idio.MKT	0.044	0.0383	2.11858	5.0581	0.01287	0.21942	*Poland_Idio.CNS*	0.022	0.0157	3.29599	16.546	0.01035	0.12123
India_Idio.IND	0.013	0.0099	3.1549	12.073	0.00681	0.06767	*Poland_Idio.HL*	0.043	0.0397	3.04994	13.446	0.0099	0.2795
Colombia_Idio.MKT	0.031	0.0234	2.8329	11.159	0.00861	0.16067	*Russia_Idio.MKT*	0.044	0.0394	4.06742	24.004	0.01419	0.31604
Colombia_Idio.OIL	0.019	0.0123	3.18855	14.334	0.00819	0.09271	*Russia_Idio.OIL*	0.007	0.0053	1.95783	3.1537	0.0031	0.02609
Colombia_Idio.CNS	0.019	0.0091	3.12898	10.507	0.01398	0.06166	*Russia_Idio.BM*	0.022	0.0141	3.17651	12.385	0.01241	0.09984
Colombia_Idio.UT	0.014	0.0085	2.64305	7.1637	0.00745	0.05126	*Russia_Idio.UT*	0.028	0.0159	1.87986	5.0833	0.00987	0.10155
CZ_Idio.MKT	0.038	0.0322	3.08983	12.147	0.01155	0.21762	*SouthAfrica_Idio.MKT*	0.049	0.0327	3.98178	24.26	0.02155	0.27414
CZ_Idio.OIL	0.03	0.0222	2.74579	10.484	0.0114	0.15412	*SouthAfrica_Idio.OIL*	0.029	0.0196	1.50425	1.8794	0.0132	0.10252
CZ_Idio.CNS	0.027	0.0197	3.03608	11.038	0.01343	0.12448	*SouthAfrica_Idio.BM*	0.025	0.017	1.30823	0.6861	0.00991	0.07801
CZ_Idio.CN	0.045	0.0484	3.20899	12.872	0.01142	0.31523	*Thailand_Idio.MKT*	0.042	0.0319	3.01893	14.422	0.01339	0.23309
Hungary_Idio.MKT	0.041	0.028	3.19491	16.759	0.01902	0.22048	*Thailand_Idio.OIL*	0.018	0.0137	2.08503	3.7924	0.00823	0.06474
Hungary_Idio.OIL	0.029	0.0205	1.86736	2.7214	0.01459	0.09906	*Thailand_Idio.BM*	0.019	0.0227	5.25142	37.164	0.00709	0.19393
Hungary_Idio.BM	0.031	0.0258	3.50848	15.114	0.01278	0.17436	*Thailand_Idio.IND*	0.019	0.0082	2.02728	4.2488	0.00816	0.04977
Hungary_Idio.HL	0.03	0.0198	1.83474	4.0985	0.0138	0.12064	*Thailand_Idio.CNS*	0.02	0.0132	2.24925	5.5326	0.01118	0.08214
Hungary_Idio.CN	0.028	0.0272	4.38864	21.9	0.01546	0.18962	*Thailand_Idio.HL*	0.024	0.021	2.50353	6.4463	0.01187	0.11819
Hungary_Idio.TEL	0.029	0.0204	1.97038	3.8235	0.01382	0.11252	*Turkey_Idio.MKT*	0.05	0.0374	3.12286	12.204	0.0236	0.25381
Hungary_Idio.UT	0.037	0.0308	2.232	5.1759	0.01554	0.16322	*Turkey_Idio.BM*	0.03	0.0198	1.35422	1.3497	0.01129	0.10133
							Idio.GLOBE	0.023	0.0253	2.78242	8.9493	0.00601	0.14111

Table 5: Channel Performance Using Equation (11) for Average, Above Average and Below Average Open Markets

This table presents the estimation results of *Equation (11):* $Contg_{i,j,t} = \alpha_{0_{i,j}} + \alpha_{1_{i,j}}\sigma_{i,j,t} + \alpha_{2_{i,j}}\sigma_{j,t} + \alpha_{3_{i,j}}\sigma_{wd,t}$(i is sector, j is country. $Contg_{i,j,t}$ is a time series of contagion magnitude of sector i in country j at time t. $\sigma_{i,j,t}$ is the idiosyncratic volatility of sector i in country j at time t. $\sigma_{j,t}$ is the idiosyncratic volatility of country j at time t. $\sigma_{wd,t}$ is the idiosyncratic volatility of the world at time t). $\sigma_{i,j,t}$, $\sigma_{j,t}$ and $\sigma_{wd,t}$ each have 95 observations and are estimated from sector, country and global asymmetric GARCH (1,1) models. $Contg_{i,j,t}$ is estimated by the Kalman filter. For ease of comparison, the coefficient of each channel is standardized. Robust t statistics are output as well. We also do an F test on the sum of the coefficients. H_0: sum of coefficients=0; H_a: sum of coefficients $\neq 0$. We output the P-value for the test of the sum of coefficients. The following abbreviations are adopted: Oil and gas (OIL), basic materials (BM), industrials (IND), consumer goods (CNS), health care (HL), consumer services (CN), telecommunications (TEL), utilities (UT), financials (FIN), technology (TEC), total market return (MKT), *Idio.MKT* represents idiosyncratic volatility (std.dev) of country, *Idio.GLOBE* is the idiosyncratic volatility (std.dev) of global and *Idio.(sector i)* is the idiosyncratic volatilities (std.dev) of sector i. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. CZ stands for Czech Republic.

Table 5: Channel Performance Using Equation (11) for Average, Above Average and Below Average Open Markets

Panel A - Above average open markets

CZ-OIL	*Std.Coefficients*	*t Stat*	*P-value*	*R-square*	*P-value for sum of coefficients*	***Hungary-BM***	*Std.Coefficients*	*t Stat*	*P-value*	*R-square*	*P-value for sum of coefficients*
Intercept	0	82.9	<.0001	0.1245***	0.005	Intercept	0	5.89	<.0001	0.1109**	0.8916
Idio.SEC	-0.20361*	-1.74	0.0854			Idio.SEC	0.19101*	1.9	0.0601		
Idio.MKT	0.22415*	1.7	0.0918			Idio.MKT	0.11737	1.15	0.2528		
Idio.GLOBE	-0.29409**	-1.99	0.0491			Idio.GLOBE	-0.31375***	-3.04	0.0031		
CZ-CNS						**Hungary-CN**					
Intercept	0	-0.59	0.5567	0.1524***	0.83	Intercept	0	6.46	<.0001	0.0717*	0.0801
Idio.SEC	0.22242**	2.29	0.0244			Idio.SEC	-0.01025	-0.1	0.92		
Idio.MKT	0.25115*	1.93	0.0568			Idio.MKT	-0.003	-0.03	0.9772		
Idio.GLOBE	-0.45055***	-3.47	0.0008			Idio.GLOBE	-0.26644**	-2.56	0.0122		
CZ-CN						**Hungary-TEL**					
Intercept	0	11.52	<.0001	0.0742*	0.0237	Intercept	0	0.89	0.3738	0.0768*	0.9713
Idio.SEC	0.07989	0.67	0.506			Idio.SEC	0.16019	1.59	0.1156		
Idio.MKT	-0.24319*	-1.7	0.0922			Idio.MKT	0.02674	0.26	0.7974		
Idio.GLOBE	-0.08554	-0.62	0.5345			Idio.GLOBE	-0.22959**	-2.21	0.0294		
Hungary-OIL						**Hungary-UT**					
Intercept	0	10.01	<.0001	0.1214***	0.0007	Intercept	0	34.82	<.0001	0.1212***	0.0063
Idio.SEC	-0.26502**	-2.57	0.0119			Idio.SEC	0.01516	0.15	0.8842		
Idio.MKT	-0.13577	-1.34	0.1842			Idio.MKT	-0.30523***	-3	0.0035		
Idio.GLOBE	-0.09857	-0.93	0.3568			Idio.GLOBE	-0.11087	-1.04	0.3023		
Hungary-HL											
Intercept	0	5.86	<.0001	0.132**	0.9748						
Idio.SEC	0.23658**	2.41	0.0181								
Idio.MKT	0.00502	0.05	0.9604								
Idio.GLOBE	-0.30153	-2.98	0.0037								

Table 5: Panel B - Average Open Markets

Malaysia-BM	*Std.Coefficients*	*t Stat*	*P-value*	*R-square*	*P-value for sum of coefficients*
Intercept	0	105.42	<.0001	0.24***	0.8411
Idio.SEC	0.05162	0.54	0.5932		
Idio.MKT	0.2743***	2.96	0.0039		
Idio.GLOBE	-0.40075***	-4.2	<.0001		
Malaysia-IND					
Intercept	0	72.24	<.0001	0.1966***	0.2781
Idio.SEC	-0.34888***	-2.94	0.0042		
Idio.MKT	0.54423***	4.58	<.0001		
Idio.GLOBE	-0.07887	-0.84	0.4044		
Malaysia-CNS					
Intercept	0	113.75	<.0001	0.0944**	0.161
Idio.SEC	-0.16092	-1.54	0.1262		
Idio.MKT	0.18027*	1.79	0.0762		
Idio.GLOBE	-0.1603	-1.54	0.126		
Malaysia-UT					
Intercept	0	43.72	<.0001	0.2658***	0.3826
Idio.SEC	-0.29237***	-2.93	0.0043		
Idio.MKT	0.53157***	5.33	<.0001		
Idio.GLOBE	-0.16496*	-1.83	0.0698		
Chile-OIL					
Intercept	0	25.67	<.0001	0.2897***	0.5054
Idio.SEC	-0.09235	-1.03	0.308		
Idio.MKT	0.38442***	4.21	<.0001		
Idio.GLOBE	-0.44334***	-4.79	<.0001		
Chile-BM					
Intercept	0	280.84	<.0001	0.1575***	0.0446
Idio.SEC	-0.24154**	-2.49	0.0147		
Idio.MKT	0.23638**	2.38	0.0196		
Idio.GLOBE	-0.27357***	-2.76	0.0071		

Chile-CN	*Std.Coefficients*	*t Stat*	*P-value*	*R-square*	*P-value for sum of coefficients*
Intercept	0	54.67	<.0001	0.2580***	0.4576
Idio.SEC	0.16501*	1.72	0.0889		
Idio.MKT	-0.45904***	-4.83	<.0001		
Idio.GLOBE	0.31687***	3.32	0.0013		
Chile-UT					
Intercept	0	130.72	<.0001	0.1301***	0.241
Idio.SEC	0.03556	0.36	0.7172		
Idio.MKT	0.1888*	1.88	0.0639		
Idio.GLOBE	0.26213**	2.6	0.0108		
Poland-IND					
Intercept	0	30.73	<.0001	0.1654***	0.5018
Idio.SEC	0.0872	0.91	0.3659		
Idio.MKT	0.18459*	1.67	0.0989		
Idio.GLOBE	-0.46184***	-4.16	<.0001		
Poland-CNS					
Intercept	0	6.04	<.0001	0.1059**	0.0272
Idio.SEC	-0.09538	-0.96	0.3399		
Idio.MKT	0.08289	0.72	0.4721		
Idio.GLOBE	-0.34793***	-3.04	0.0031		
Korea-OIL					
Intercept	0	30.91	<.0001	0.1183***	0.3603
Idio.SEC	0.06849	0.67	0.5068		
Idio.MKT	-0.32412***	-2.98	0.0037		
Idio.GLOBE	-0.05634	-0.52	0.6024		
Korea-BM					
Intercept	0	32.02	<.0001	0.1668***	0.0199
Idio.SEC	-0.16132*	-1.68	0.0956		
Idio.MKT	0.25243**	2.47	0.0155		
Idio.GLOBE	-0.38797***	-3.79	0.0003		

Thailand-BM	*Std.Coefficients*	*t Stat*	*P-value*	*R-square*	*P-value for sum of coefficients*
Intercept	0	45.11	<.0001	0.1942***	0.6517
Idio.SEC	0.23668**	2.01	0.0469		
Idio.MKT	-0.57443***	-4.64	<.0001		
Idio.GLOBE	0.13752	1.27	0.2083		
Thailand-IND					
Intercept	0	27.12	<.0001	0.2033***	0.2793
Idio.SEC	-0.00173	-0.02	0.986		
Idio.MKT	0.24778**	2.23	0.0283		
Idio.GLOBE	-0.51449***	-4.82	<.0001		
Thailand-CNS					
Intercept	0	105.77	<.0001	0.0926**	0.0056
Idio.SEC	0.21203**	2.02	0.0464		
Idio.MKT	0.12009	1.03	0.3056		
Idio.GLOBE	0.06593	0.58	0.5666		
Thailand-HL					
Intercept	0	7.27	<.0001	0.2112***	0.0943
Idio.SEC	-0.03444	-0.37	0.7137		
Idio.MKT	0.37415***	3.52	0.0007		
Idio.GLOBE	-0.49706***	-4.66	<.0001		
South Africa-OIL					
Intercept	0	8.22	<.0001	0.041	-
Idio.SEC	-0.20986*	-1.87	0.0647		
Idio.MKT	0.08052	0.65	0.5167		
Idio.GLOBE	-0.01642	-0.13	0.897		
South Africa-BM					
Intercept	0	7.89	<.0001	0.0183	-
Idio.SEC	-0.1285	-1.15	0.2549		
Idio.MKT	0.07963	0.63	0.533		
Idio.GLOBE	-0.05632	-0.45	0.6533		

Table 5: Panel B-Continued

Chile-IN	*Std.Coefficients*	*t Stat*	*P-value*	*R-square*	*P-value for sum of coefficients*	**Korea-IND**	*Std.Coefficients*	*t Stat*	*P-value*	*R-square*	*P-value for sum of coefficients*	**Colombia-OIL**	*Std.Coefficients*	*t Stat*	*P-value*	*R-square*	*P-value for sum of coefficients*
Intercept	0	100.67	<.0001	0.3126***	0.4485	Intercept	0	67.83	<.0001	0.0328	-	Intercept	0	281.4	<.0001	0.0596	-
Idio.SEC	-0.11585	-1.29	0.1997			Idio.SEC	0.03083	0.29	0.7744			Idio.SEC	-0.0473	-0.27	0.786		
Idio.MKT	0.54961***	5.99	<.0001			Idio.MKT	0.18213	1.59	0.1143			Idio.MKT	0.07467	0.43	0.6664		
Idio.GLOBE	-0.3227***	-3.6	0.0005			Idio.GLOBE	-0.05982	-0.54	0.5885			Idio.GLOBE	-0.24323**	-2.34	0.0216		
Chile-CNS						**Korea-UT**						**Colombia-CN**					
Intercept	0	47.05	<.0001	0.3212***	0.0329	Intercept	0	27.55	<.0001	0.0931**	0.2531	Intercept	0	128.25	<.0001	0.1235***	0.8283
Idio.SEC	0.04214	0.48	0.6303			Idio.SEC	0.05778	0.58	0.5649			Idio.SEC	0.0298	0.28	0.782		
Idio.MKT	0.56149***	6.32	<.0001			Idio.MKT	0.0256	0.24	0.8111			Idio.MKT	-0.32868***	-3.06	0.0029		
Idio.GLOBE	-0.28586***	-3.19	0.002			Idio.GLOBE	-0.30964***	-2.9	0.0047			Idio.GLOBE	0.21258**	2.12	0.0371		
Chile-HL						**Thailand-OIL**						**Colombia-UT**					
Intercept	0	76.03	<.0001	0.0311	-	Intercept	0	7.32	<.0001	0.0512	-	Intercept	0	61.85	<.0001	0.1184***	0.9164
Idio.SEC	0.10301	0.95	0.3454			Idio.SEC	0.24203**	2.09	0.0394			Idio.SEC	0.02714	0.27	0.7864		
Idio.MKT	-0.07026	-0.66	0.5138			Idio.MKT	-0.04957	-0.39	0.6995			Idio.MKT	0.22868**	2.26	0.0259		
Idio.GLOBE	-0.14848	-1.35	0.1793			Idio.GLOBE	-0.08801	-0.76	0.4522			Idio.GLOBE	-0.29422***	-2.92	0.0045		
												Turkey-BM					
												Intercept	0	41.54	<.0001	0.1271***	0.0026
												Idio.SEC	-0.35641***	-3.54	0.0006		
												Idio.MKT	0.07205	0.64	0.5231		
												Idio.GLOBE	-0.04571	-0.41	0.6848		

Table 5: Panel C - Below Average Open Markets

China-BM	*Std.Coefficients*	*t Stat*	*P-value*	*R-square*	*P-value for sum of coefficients*	***Philippines-CNS***	*Std.Coefficients*	*t Stat*	*P-value*	*R-square*	*P-value for sum of coefficients*
Intercept	0	104.7	<.0001	0.2104***	0.0151	Intercept	0	14.09	<.0001	0.1396***	0.5157
Idio.SEC	-0.04337	-0.44	0.6597			Idio.SEC	-0.06685	-0.68	0.496		
Idio.MKT	-0.44026***	-4.63	<.0001			Idio.MKT	0.28502***	2.88	0.0049		
Idio.GLOBE	-0.04348	-0.45	0.6551			Idio.GLOBE	-0.28816***	-2.91	0.0045		
China-IND						**Russia-OIL**					
Intercept	0	61.81	<.0001	0.069*	0.8562	Intercept	0	9.77	<.0001	0.23***	<.0001
Idio.SEC	0.04658	0.46	0.6464			Idio.SEC	-0.38113***	-4.01	0.0001		
Idio.MKT	-0.25993**	-2.55	0.0124			Idio.MKT	-0.09706	-0.76	0.4483		
Idio.GLOBE	0.00824	0.08	0.9357			Idio.GLOBE	-0.13821	-1.06	0.2914		
China-CNS						**Russia-BM**					
Intercept	0	36.38	<.0001	0.0504	-	Intercept	0	19.08	<.0001	0.2332***	<.0001
Idio.SEC	0.06482	0.63	0.5281			Idio.SEC	-0.17939*	-1.89	0.0619		
Idio.MKT	-0.11179	-1.09	0.2799			Idio.MKT	0.13893	1.08	0.2836		
Idio.GLOBE	-0.17495*	-1.7	0.093			Idio.GLOBE	-0.50546***	-3.97	0.0001		
China-CN						**Russia-UT**					
Intercept	0	61.26	<.0001	0.0819**	0.2587	Intercept	0	10.65	<.0001	0.1494***	0.0012
Idio.SEC	0.17129*	1.67	0.0978			Idio.SEC	-0.38072***	-3.8	0.0003		
Idio.MKT	-0.2461**	-2.39	0.0189			Idio.MKT	-0.15541	-1.16	0.2487		
Idio.GLOBE	0.12985	1.28	0.2035			Idio.GLOBE	0.15685	1.15	0.254		
China-UT						**India-IND**					
Intercept	0	28.38	<.0001	0.17***	0.9081	Intercept	0	28.3	<.0001	0.2063***	0.2757
Idio.SEC	0.11272	1.18	0.2412			Idio.SEC	-0.00043	0	0.9964		
Idio.MKT	0.21512**	2.24	0.0277			Idio.MKT	0.28294***	2.85	0.0054		
Idio.GLOBE	-0.35542***	-3.69	0.0004			Idio.GLOBE	-0.46214***	-4.65	<.0001		

Table 6: Summarizing the Type of Channel Performance by Degree of Market Openness

Based on the results in Table 5, this table shows the frequency that a channel encourages/discourages contagion by degree of market openness. The frequencies are expressed in percentage and summarize the statistically significant outcomes from estimation of *Equation (11):* $Contg_{i,j,t} = \alpha_{0_{i,j}} + \alpha_{1_{i,j}}\sigma_{i,j,t} + \alpha_{2_{i,j}}\sigma_{j,t} + \alpha_{3_{i,j}}\sigma_{wd,t}$(i is sector, j is country. $Contg_{i,j,t}$ is a time series of contagion magnitude of sector i in country j at time t. $\sigma_{i,j,t}$ is the idiosyncratic volatility of sector i in country j at time t, $\sigma_{j,t}$ is the idiosyncratic volatility of country j at time t and $\sigma_{wd,t}$ is the idiosyncratic volatility of the world at time t). $\sigma_{i,j,t}$, $\sigma_{j,t}$ and $\sigma_{wd,t}$ each have 95 observations and are estimated from sector, country and global asymmetric GARCH(1,1) models. $Contg_{i,j,t}$ is estimated by the Kalman filter. For ease of comparison, the coefficient of each channel is standardized. The following abbreviations are adopted: Oil and gas (OIL), basic materials (BM), industrials (IND), consumer goods (CNS), health care (HL), consumer services (CN), telecommunications (TEL), utilities (UT), financials (FIN), technology (TEC), total market return (MKT), *Idio.MKT* represents idiosyncratic volatility (std.dev) of country, *Idio.GLOBE* is the idiosyncratic volatility (std.dev) of global and *Idio.(sector i)* is the idiosyncratic volatilities (std.dev) of sector i.

N= number of country-industries in each category. *NOTE: The sum of the percentage for each channel discouraging and encouraging contagion is not equal to 100%, because each channel is not necessarily statistically significant in every case.*

Degree of market openness	***Channel Performance***	***Global channel***	***Country channel***	***Sector channel***
Above average open (N=9)	**Encourage**	0%	22%	22%
	Discourage	67%	22%	33%
Average open (N=21)	**Encourage**	14%	62%	14%
	Discourage	57%	19%	29%
Below average open(N=9)	**Encourage**	0%	33%	22%
	Discourage	56%	33%	11%
Total (N=39)	**Encourage**	8%	46%	18%
	Discourage	62%	23%	26%

Table 7: Channel Performance by Industrial Classification

This table groups the findings of channel performance (Table 5) by industry. Table 5 results are from estimation of *Equation (11):* $Contg_{i,j,t} = \alpha_{0\ i,j} + \alpha_{1\ i,j}\sigma_{i,j,t} + \alpha_{2\ i,j}\sigma_{wd,t} + \alpha_{3\ i,j}\sigma_{j,t}$ (i is sector, j is country. $Contg_{i,j,t}$ is a time series of contagion magnitude of sector i in country j at time t. $\sigma_{i,j,t}$ is the idiosyncratic volatility of sector i in country j at time t, $\sigma_{j,t}$ is the idiosyncratic volatility of country j at time t and $\sigma_{wd,t}$ is the idiosyncratic volatility of the world at time t). $\sigma_{i,j,t}$, $\sigma_{j,t}$ and $\sigma_{wd,t}$ each have 95 observations and are estimated from sector, country and global asymmetric GARCH(1,1) models. $Contg_{i,j,t}$ is estimated by the Kalman filter. For ease of comparison, the coefficient of each channel is standardized. Robust t statistics are output as well. The following abbreviations are adopted: Oil and gas (OIL), basic materials (BM), industrials (IND), consumer goods (CNS), health care (HL), consumer services (CN), telecommunications (TEL), utilities (UT), financials (FIN), technology (TEC), total market return (MKT), *Idio.MKT* represents idiosyncratic volatility (std.dev) of country, *Idio.GLOBE* is the idiosyncratic volatility (std.dev) of global and *Idio.(sector i)* is the idiosyncratic volatilities (std.dev) of sector i. CZ stands for Czech Republic.

Table 7: Channel Performance by Industrial Classification

Country-Sector		*CZ-OIL*	*Hungary-OIL*	*Korea-OIL*	*Russia-OIL*	*Chile-OIL*		
OIL	Idio.SEC	-0.20361*	-0.26502**	0.06849	-0.38113***	-0.09235		
	Idio.MKT	0.22415*	-0.13577	-0.32412***	-0.09706	0.38442***		
	Idio.GLOBE	-0.29409**	-0.09857	-0.05634	-0.13821	-0.44334***		
		Hungary-BM	**China-BM**	**Russia-BM**	**Thailand-BM**	**Turkey-BM**	**Chile-BM**	**Korea-BM**
BM	Idio.SEC	0.19101*	-0.04337	-0.17939*	0.23668**	-0.35641***	-0.24154**	-0.16132*
	Idio.MKT	0.11737	-0.44026***	0.13893	-0.57443***	0.07205	0.23638**	0.25243**
	Idio.GLOBE	-0.31375***	-0.04348	-0.50546***	0.13752	-0.04571	-0.27357***	-0.38797***
		China-IND	**Malaysia-IND**	**Poland-IND**	**Thailand-IND**	**India-IND**	**Chile-IND**	
IND	Idio.SEC	0.04658	-0.34888***	0.0872	-0.00173	-0.00042915	-0.11585	
	Idio.MKT	-0.25993**	0.54423***	0.18459*	0.24778**	0.28294***	0.54961***	
	Idio.GLOBE	0.00824	-0.07887	-0.46184***	-0.51449***	-0.46214***	-0.3227***	
		CZ-CNS	**Philippines-CNS**	**Malaysia-CNS**	**Chile-CNS**	**Poland-CNS**	**Thailand-CNS**	
CNS	Idio.SEC	0.22242**	-0.06685	-0.16092	0.04214	-0.09538	0.21203**	
	Idio.MKT	0.25115*	0.28502***	0.18027*	0.56149***	0.08289	0.12009	
	Idio.GLOBE	-0.45055***	-0.28816***	-0.1603	-0.28586***	-0.34793***	0.06593	
		Hungary-HL	**Thailand-HL**					
HL	Idio.SEC	0.23658**	-0.03444					
	Idio.MKT	0.00502	0.37415***					
	Idio.GLOBE	-0.30153***	-0.49706***					
		CZ-CN	**China-CN**	**Hungary-CN**	**Chile-CN**	**Colombia-CN**		
CN	Idio.SEC	0.07989	0.17129*	-0.01025	0.16501*	0.0298		
	Idio.MKT	-0.24319*	-0.2461**	-0.003	-0.45904***	-0.32868***		
	Idio.GLOBE	-0.08554	0.12985	-0.26644**	0.31687***	0.21258**		
		Hungary-TEL						
TEL	Idio.SEC	0.16019						
	Idio.MKT	0.02674						
	Idio.GLOBE	-0.22959**						
		Hungary-UT	**China-UT**	**Russia-UT**	**Malaysia-UT**	**Chile-UT**	**Korea-UT**	**Colombia-UT**
UT	Idio.SEC	0.01516	0.11272	-0.38072***	-0.29237***	0.03556	0.05778	0.02714
	Idio.MKT	-0.30523***	0.21512**	-0.15541	0.53157***	0.1888*	0.0256	0.22868**
	Idio.GLOBE	-0.11087	-0.35542***	0.15685	-0.16496*	0.26213**	-0.30964***	-0.29422***

Table 8: Type of Channel Performance by Industry

This table summarizes the outcomes reported in Table 7 by noting the frequency with which each channel significantly encourages or discourages contagion in each industry. For example, there are 5 countries with oil sectors identified as contagious, 3/5 of these show that the sector channel mitigates contagion, 1/5 have a country channel that encourages contagion and 1/5 discourage contagion while the global channel discourages contagion for 2/5. The industry abbreviations are as follows: Oil and gas (OIL), basic materials (BM), industrials (IND), consumer goods (CNS), health care (HL), consumer services (CN), telecommunications (TEL), utilities (UT), financials (FIN), technology (TEC). N is the number of countries in each industry.

	Sector channel		***Country channel***		***Global channel***	
Industry	**Encourage**	**Discourage**	**Encourage**	**Discourage**	**Encourage**	**Discourage**
OIL(N=5)	0	3	1	1	0	2
BM(N=7)	2	4	2	2	0	4
IND(N=6)	0	1	5	1	0	4
CNS(N=6)	2	0	4	0	0	4
HL(N=2)	1	0	1	0	0	2
CN(N=5)	2	0	0	4	2	1
TEL(N=1)	0	0	0	0	0	1
UT(N=7)	0	2	4	1	1	4
TOTAL(N=39)	7	10	17	9	3	22

Table 9: Channel Performance as the Severity of Contagion Increases

This table summarizes the graphs of Figure 1 by reporting the frequency (expressed in percent) that a channel discourages contagion across all degrees of contagion, or encourages contagion at all degrees of contagion or shifts between the two. The industry abbreviations are as follows: Oil and gas (OIL), basic materials (BM), industrials (IND), consumer goods (CNS), health care (HL), consumer services (CN), telecommunications (TEL), utilities (UT), financials (FIN), technology (TEC).

Percentage	***Channel performance***	***Global channel***	***Country channel***	***Sector channel***
(Number of channel in each case) / (Total sectors= 39)	**Discourage**	41%	15%	28%
	Encourage	3%	31%	3%
	Shift	56%	54%	69%

Table 10: Robustness Check-Contagion Detection

This table reports the estimates of contagion $\beta_{2\,i,j}$ from equation (1) with an alternate proxy for the world market in E$quation$ (1): $R_{i,j,t} = \beta_{0,i,j} + \beta_{1i,j}R_{fin,j,t} + \beta_{2\,i,j}R_{fin,j,t} * D_{crisis} + \beta_{3\,i,j}D_{crisis} + \beta_{4\,i,j}R_{world\_MK} + \varepsilon_t$ (i is sector, j is country and t is time). If there is contagion, $\beta_{2,i,j}$ is positive and significant. Otherwise, there is no contagion. $R_{i,j,t}$ is the return of an individual industry index i in country j , $R_{fin,j,t}$ is the financial sector return of country j, R_{world_MK} is the return of the world market, D_{crisis} is the crisis dummy. The pre-crisis period is from Nov. 2001 to Aug. 2007 and the crisis period is from Sept. 2007 to June 2009. Within the crisis period, $D_{crisis} = 1$, otherwise $D_{crisis} = 0$. The industry abbreviations are as follows: Oil and gas (OIL), basic materials (BM), industrials (IND), consumer goods (CNS), health care (HL), consumer services (CN), telecommunications (TEL), utilities (UT), financials (FIN), technology (TEC). For ease of exposition, the results are in Panels A – C. ***, **, and * indicate, respectively, significance at the 1%, 5%, and 10% levels. CZ represents for Czech Republic.

Panel A

Country / Sector	***Brazil***	***China***	***Chile***	***Colombia***	***CZ***	***Greece***	***Hungary***	***India***
OIL	-0.18724**	0.00376	0.17539***	0.70722***	0.39272***	-0.08459**	0.23033***	-0.0114
BM	-0.12421	0.18507***	0.18607***	-0.22030***	-0.33858***	-0.0534*	0.16783***	-0.0393
IND	-0.39259***	0.20654***	0.19843***	-0.05357	-0.01867	-0.25897***	0.08525	0.04183*
CNS	-0.24216***	0.10607***	0.04425	-0.05595	0.10524***	-0.25933***	0.02544	-0.18522***
HL		0.04456	0.4239***		-0.32180***		0.24911***	-0.09731***
CN		0.21419***	0.22701***	0.13697**	0.32237***	-0.18502***	0.08192*	-0.09095***
TEL	-0.42852***	-0.01904	-0.16416***		-0.13094***	-0.06654**	0.07676**	0.00662
UT	-0.72181***	0.10424***	0.05525*	0.19517***	-0.01577	-0.01338	0.32536***	-0.10248***
TEC		0.11566***		0.31717***	-0.02542	-0.55235***	-0.03357	-0.06120*

Table 10: Panel B

Country / Sector	Korea	Malaysia	Philippines	Poland	Russia	South Africa	Thailand	Turkey
OIL	0.1875***	-0.00814	-0.54037***	-0.14327***	0.16008***	0.161***	0.36997***	-0.02431
BM	0.06999**	0.04879	-0.14334	0.00111	0.05383*	-0.03599	0.27265***	0.14914***
IND	0.10464***	0.11021***	0.03491	0.14533***		-0.08054***	0.11409**	-0.05764**
CNS	-0.15199***	0.13184***	0.24375***	0.12605***		-0.08504**	0.16573***	-0.12869***
HL	-0.06011	-0.08862	-0.07681	0.15779***		-0.06633***	0.04358	-0.20595***
CN	-0.02138	-0.00219	0.04397	-0.09161***	-0.03654	-0.03632*	-0.02387	-0.23094***
TEL	-0.12005***	-0.04257	-0.08211*	-0.24783***	-0.02188	-0.03837	-0.18591***	-0.17082***
UT	0.38048***	0.09619***	-0.07195	0.00565	0.13562***		-0.01339	-0.02956
TEC	-0.14425***			-0.16951***		-0.16819***	-0.33613***	0.04143

Table 11-A: Robustness check-Comparison between GARCH (1, 1) and asymmetric GARCH (1, 1) --- Global Model

This table compares GARCH (1,1) and asymmetric GARCH(1,1) for the global model in *Equation (8):* $r_{wd,t} = \boldsymbol{\delta_{wd,t}}'\boldsymbol{X_{wd,t-1}} + e_{wd,t}$ ($r_{wd,t}$ is the excess return of the world return, vector $\boldsymbol{X_{wd,t-1}}$ is a set of world information variables including a constant, world market dividend yield, the default spread (Moody's Baa minus Aaa bond yields), the change in the term structure spread (US 10-year bond yield minus 3-month US T-bill rate), and the change in the 30-day Eurodollar rate). We compare GARCH (1,1): $\sigma_t^2 = a + b\sigma_{t-1}^2 + ce_{t-1}^2$ and asymmetric GARCH(1,1): $\sigma_t^2 = a + b\sigma_{t-1}^2 + ce_{t-1}^2 + d\eta_{t-1}^2$. We choose the model of better fit by comparing the Akaike information criterion (AIC), Schwarz's Bayesian criterion (SBC) and the log likelihood. We conduct Ljung-Box Q-test and LM tests on the mean and variance equations to test our model specification and we output the significant coefficients of both models as well.

Globe							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	4733.723	4392.71/4398.04	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	4606.301	4398.14/4403.48	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH (1)	arch0,arch1	4452	4633.48/4638.81	Fail to reject	Fail to reject	Fail to reject	Fail to reject

Table 11-B: Robustness check-Comparison between GARCH (1, 1) and asymmetric GARCH (1, 1) --- Country Model

This table compares GARCH (1,1) and asymmetric GARCH(1,1) for the country model in *Equation (5):* $r_{j,t} = \boldsymbol{\delta_{j,t}}'\boldsymbol{X_{j,t-1}} + \omega^{w}_{i,j,t-1}\mu_{w,t-1} + \omega^{w}_{i,j,t-1}e_{w,t} + e_{j,t}$ ($r_{j,t}$ is the daily return of country j in excess of the home country's 3-month bill rate, $X_{j,t-1}$ is the information set of country j, $\mu_{w,t-1}$ is the expected return on the global market in excess of the home country's 3-month T-bill rate, conditional on information available at time $t-1$, and $e_{w,t}$ is the residual of the excess expected return of the global market. All of the excess returns are expressed in US dollars. The fundamentals include a constant, market dividend yield and the lagged exchange rate). We compare GARCH (1,1): $\sigma_t^2 = a + b\sigma_{t-1}^2 + ce_{t-1}^2$ and asymmetric GARCH(1,1): $\sigma_t^2 = a + b\sigma_{t-1}^2 + ce_{t-1}^2 + d\eta_{t-1}^2$.We choose the model of better fit by comparing the Akaike information criterion (AIC), Schwarz's Bayesian criterion (SBC) and the log likelihood. We conduct Ljung-Box Q-test and LM tests on the mean and variance equations to test our model specification and we output the significant coefficients of both models as well. The results are split into Panels A- C.

Panel A

China-MKT							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1, phi	3587.635	4342.12/ 4347.46	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3463.477	4397.05/ 4402.38	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0,arch1	3437	4420.23/4425.56	Fail to reject	Fail to reject	Fail to reject	Fail to reject
India-MKT							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1, phi	3380.694	4278.53/4283.87	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3265.101	4472.21/4477.54	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0,arch1	3433.125	4251.07/4256.41	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Chile-MKT							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	3774.328	4254.77/4260.10	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3686.463	4415.56/4420.89	Fail to reject	Fail to reject	Fail to reject	Fail to reject

Table 11-B: Panel A-Continued

Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
ARCH(1)	arch0,arch1	3976.511	4636.41/4641.75	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Colombia-MKT							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	3891.989	4321.3/4326.64	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3795.125	4376.26/4381.59	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	3850.282	4054.2/4059.53	Fail to reject	Fail to reject	Fail to reject	Fail to reject
CZ-MKT							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	3768.786	4343.35/4348.69	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3629.352	4413.12/4418.45	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0,arch1	3405.468	3759.84/3765.17	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Hungary-MKT							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	3143.121	4353.38/4358.71	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3075.459	4513.08/4518.41	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	3203.047	4155.5/4160.83	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Turkey-MKT							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1	1524.566	4429.33/4434.67	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	1524.405	4429.05/4434.38	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0,arch1	2850.781	4416.52/4421.85	Fail to reject	Fail to reject	Fail to reject	Fail to reject

Table 11-B: Panel B

Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
Thailand-MKT							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	3786.203	4342.88/4348.21	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3664.289	4364.44/ 4369.78	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	3514.258	4529.65/ 4534.98	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Korea-MKT							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	3481.699	4359.14/4364.47	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3415.292	4844.16/4849.50	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0,arch1	3368.577	4200.32/4205.65	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Philippines-MKT							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	3726.287	4341.34/4346.67	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3657.247	4360.66/4365.99	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0,arch1	3813.905	4521.64/4526.97	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Poland-MKT							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	3461.845	4353.07/4358.40	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3338.228	4437.48/ 4442.81	Fail to reject	Fail to reject	Fail to reject	Fail to reject

Table 11-B: Panel B-Continued

Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
ARCH(1)	arch0,arch1	3335.979	4678.62/4683.96	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Malaysia-MKT							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	4851.395	4329.65/4334.98	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	4690.827	4374.28/4379.61	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4260.348	4447.05432/4452.38	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Russia-MKT							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	2700.027	4382.56/4387.89	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	2692.996	4481.26/4486.59	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4260.348	4447.05/4452.38	Fail to reject	Fail to reject	Fail to reject	Fail to reject
South Africa-MKT							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	2728.012	4059.83/4065.10	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	2690.118	4407.25/4412.51	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0,arch1	2699.474	3961.52/ 3966.78	Fail to reject	Fail to reject	Fail to reject	Fail to reject

Table 11-C: Robustness Check-Comparison Between GARCH (1, 1) and Asymmetric GARCH (1, 1) --- Sector Model

This table compares GARCH (1,1) and asymmetric GARCH(1,1) for the sector model in *Equation (2):* $r_{i,j,t} = \boldsymbol{\delta_{i,j}}'\boldsymbol{X_{i,j,t-1}} + \omega^{j}_{i,j,t-1}\mu_{j.t-1} + \omega^{j}_{i,j,t-1}e_{j,t} + e_{i,j,t}$ (vector $\boldsymbol{X_{i,j,t-1}}$ contains a set of local economic information variables that estimate the expected return of sector i including a constant, a lagged sector return and a market dividend yield. $r_{i,j,t}$ is the return of sector i in country j in excess of the home country's 3-month T-bill rate, the expected returns on the market of country j *in* excess of the home country's 3-month T-bill rate, conditional on information available at time $t-1$ is $\mu_{j,t-1}$ and the residual of the market excess return of country j is $e_{j,t}$. All the excess returns are expressed in US dollars).We compare GARCH (1,1): $\sigma_t^2 = a + b\sigma_{t-1}^2 + ce_{t-1}^2$ and asymmetric GARCH(1,1): $\sigma_t^2 = a + b\sigma_{t-1}^2 + ce_{t-1}^2 + d\eta_{t-1}^2$.We choose the model of better fit by comparing the Akaike information criterion (AIC), Schwarz's Bayesian criterion (SBC) and the log likelihood. We conduct Ljung-Box Q-test and LM tests on the mean and variance equations to test our model specification and we output the significant coefficients of both models as well. The results are spread across Panels A-E.

Panel A

Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
CZ-CNS							
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	3919.116	4342.65/4347.99	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3809.998	4342.8/4348.14	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0,arch1	3765.318	4550.72/4556.05	Fail to reject	Fail to reject	Fail to reject	Fail to reject
CZ-CN							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	3618.211	4403.97/4409.30	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3581.535	4458.35/4463.68	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0,arch1	3349.876	4608.19/4613.52	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Hungary-OIL							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	3600.186	4343.62/4348.95	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3368.576	5024.55/5029.88	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	3635.663	4597.1/4602.43	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Hungary-BM							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	3546.363	4349.1/4354.43	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3439.966	4381.98/4387.31	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	3588.07	3783.32/3788.65	Fail to reject	Fail to reject	Fail to reject	Fail to reject

Table 11-C: Panel A-Continued

Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
Hungary-HL							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	3637.251	4343.61/4348.94	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3523.88	4343.41/4348.74	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	3647.406	4583.57/4588.91	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Hungary-CN							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1,phi	3586.295	4343.95/ 4349.28	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1	3464.989	4346.05/4351.38	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	3522.178	4447.81/4453.15	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Hungary-TEL							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1,phi	3571.007	4339.61/4344.94	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1	3473.895	4342.31/4347.64	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	3686.51	4507.02/4512.36	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Hungary-UT							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	3451.846	4377.13/4382.47	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3360.533	4420.39/4425.73	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	3375.101	4344.68/ 4350.01	Fail to reject	Fail to reject	Fail to reject	Fail to reject

Table 11-C: Panel B

Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
China-BM							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0, arch1,garch1,phi	4861.891	4345.19/ 4350.53	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0, arch1,garch1	4732.681	4348.5/ 4353.84	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4701	4640.54/4645.87	Fail to reject	Fail to reject	Fail to reject	Fail to reject
China-IND							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0, arch1,phi	4936.162	4344.93/ 4350.27	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0, arch1,garch1	4791.902	4343.38/4348.71	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4774.735	4626.71/ 4632.05	Fail to reject	Fail to reject	Fail to reject	Fail to reject
China-CNS							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0, arch1,garch1,phi	4669.575	4344.47/ 4349.80	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0, arch1,garch1	4550.959	4362.69/ 4368.03	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4444.098	3758.80/3764.13	Fail to reject	Fail to reject	Fail to reject	Fail to reject
China-CN							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0, arch1,garch1,phi	4697.57	4344.56/ 4349.89	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0, arch1,garch1	4586.649	4354.12/ 4359.45	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4501.537	4560.82/ 4566.15	Fail to reject	Fail to reject	Fail to reject	Fail to reject
China-UT							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0, arch1,garch1,phi	4520.25	4342.73/ 4348.06	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0, arch1	4385.021	4346.12/4351.45	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4386.587	4343.55/ 4348.88	Fail to reject	Fail to reject	Fail to reject	Fail to reject

Table 11-C: Panel B-Continued

Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
India-IND							
Asymmetric GARCH(1,1)	arch0, arch1,phi	4838.557	4343.29/4348.62	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0, arch1	4710.727	4343.65598/ 4348.989	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4669.046	4427.22/ 4432.55	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Chile-OIL							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0, arch1,phi	4599.451	4345.02/4350.36	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	4469.55	4348.27/4353.60	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4458.357	4364.99/4370.33	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Chile-BM							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	5200.025	4345.32/4350.65	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	5062.122	4347.5/4352.83	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	5049.282	4334.89/ 4340.23	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Korea-IND							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, phi	4383.892	4345/4350.33	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	4206.965	4344.41/4349.74	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4130.794	4000.48/4005.81	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Korea-UT							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	3876.379	4350.21/4355.54	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3796.411	4359.47/4364.81	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	3855.104	4344.48/4349.81	Fail to reject	Fail to reject	Fail to reject	Fail to reject

Table 11-C: Panel B-Continued

Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
Philippines-CNS							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, phi	4396.173	4342.98/4348.31	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	4300.455	4345.82/4351.15	Fail to reject	Fail to reject	Fail to reject	Fail to reject
				Fail to reject	Fail to reject	Fail to reject	Fail to reject
Poland-IND							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	4231.811	4344.68/4350.01	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	4101.306	4342.87/4348.20	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4105.079	4580.8/4586.13	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Poland-CNS							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	4138.967	4347.23/4352.56	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3996.404	4356.08/4361.41	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	3971.593	4655.89/ 4661.22	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Poland-HL							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	3471.347	4362.02/4367.36	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3418.513	4584.74/4590.07	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	3358.298	4292.98/4298.32	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Malaysia-BM							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	4767.96	4343.22/4348.55	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	4654.655	4358.07/ 4363.40	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4586.39	4623.17/4628.50	Fail to reject	Fail to reject	Fail to reject	Fail to reject

Table 11-C: Panel B-Continued

Malaysia-IND							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	5109.338	4343.72/4349.06	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	4939.906	4342.97/4348.30	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4892.75	4481.49/4486.82	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Malaysia-CNS							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	4858.243	4342.72/4348.05	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	4709.2	4343.43/4348.76	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4667.738	4655.16/4660.49	Fail to reject	Fail to reject	Fail to reject	Fail to reject

Table 11-C: Panel C

Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
Turkey-BM							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, phi	3568.856	4344.94/ 4350.27	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3472.918	4364.13/4369.46	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0,arch1	3619.933	4348.43/ 4353.77	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Thailand-OIL							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	4446.878	4350.4/4355.73	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	4325.864	4360.63/4365.97	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4255.191	4567.79/4573.13	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Thailand-BM							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	4526.812	4348.3/4353.63	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	4420.391	4378.73/4384.06	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4354.329	4399.82/4405.15	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Thailand-IND							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	4050.99	4348.66/4353.99	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3994.493	4366.13/4371.47	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	3930.603	4521.12/4526.46	Fail to reject	Fail to reject	Fail to reject	Fail to reject

Table 11-C: Panel C-Continued

Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Thailand-CNS							
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	4062.888	4343.18/ 4348.51	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3950.382	4342.86/4348.19	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	3911.091	4021.23/4026.56	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Thailand-HL							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	4000.548	4342.56/4347.90	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3845.48	4348.56/4353.89	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	3858.998	4544.88/ 4550.22	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Korea-OIL							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1,phi	3677.066	4344.33/4349.66	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3603.701	4345.33/4350.67	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0,arch1	3612.434	4435.36/4440.69	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Korea-BM							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	4185.624	4344.36/4349.69	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1	4041.39	4342.74/4348.07	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0,arch1	4033.789	4228.07/4233.40	Fail to reject	Fail to reject	Fail to reject	Fail to reject

Table 11-C: Panel D

Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
Chile-IND							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	5003.07	4348.97/4354.30	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	4847.059	4354.89/4360.22	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4817.894	4633.77/4639.11	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Chile-CN							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	4990.652	4346.99/4352.32	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	4820.312	4347.91/4353.24	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4786.594	4657.33/ 4662.67	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Chile-HL							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	4012.322	4346.79/4352.13	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3917.167	4352.79/4358.12	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	3938.58	4508.23/4513.57	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Chile-CN							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	4980.599	4316.79/4322.12	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1	4846.631	4341.37/ 4346.70	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4827.348	4585.79/ 4591.12	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Chile-UT							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	5532.108	4343.83/4349.16	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	5396.036	4348.92/4354.26	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	5379.419	4344.74/4350.07	Fail to reject	Fail to reject	Fail to reject	Fail to reject

Table 11-C: Panel D-Continued

Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
Colombia-OIL							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	4154.027	4380.69/4386.02	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	4104.514	4370.9/4376.23	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4032.613	4479.19/4484.53	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Colombia-CN							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, phi	3897.62	4344.31/4349.64	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1	3800.106	4343.16/4348.49	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	3785.014	4514.97/ 4520.30	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Colombia-TEC							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	4278.543	4340.27/4345.60	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	4136.732	4346.22/4351.55	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4174.648	4359.26/ 4364.59	Fail to reject	Fail to reject	Fail to reject	Fail to reject
CZ-OIL							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	3712.164	4835.34/ 4840.68	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3669.242	4894.49/ 4899.82	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	3692.669	4650.09/4655.42	Fail to reject	Fail to reject	Fail to reject	Fail to reject

Table 11-C: Panel E

Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
Malaysia-UT							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, phi	5060.013	4343.64/4348.97	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1	4950.081	4348.44/4353.77	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4949.068	4343.99/4349.32	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Russia-OIL							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	5575.403	4357/4362.33	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	5452.614	4367.66/4373.00	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4307.916	4489.49/4494.83	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Russia-BM							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	4016.54	4342.84/4348.17	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1	3889.799	4349.41/4354.75	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4586.39	4623.17/4628.50	Fail to reject	Fail to reject	Fail to reject	Fail to reject
Russia-UT							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	3560.28	4418.56/4423.89	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3540.235	4452.69/4458.03	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0, arch1	4949.068	4343.99/4349.32	Fail to reject	Fail to reject	Fail to reject	Fail to reject

Table 11-C: Panel E-Continued

Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
South Africa-OIL							
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	3287.088	3899.43/3904.66	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3201.469	3918.24/3923.47	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0,arch1	3165.675	4178.15/4183.38	Fail to reject	Fail to reject	Fail to reject	Fail to reject
South Africa-BM							
Model	Significant coefficients	Log Likelihood	AIC/SBC	Diagnostics on Mean Equation		Diagnostics on Variance Equation	
				Q test(Q10)	LM test(LM10)	Q test(Q10)	LM test(LM10)
Asymmetric GARCH(1,1)	arch0,arch1, garch1,phi	3653.385	3890.94/3896.17	Fail to reject	Fail to reject	Fail to reject	Fail to reject
GARCH(1,1)	arch0,arch1, garch1	3551.042	3892.62/3897.84	Fail to reject	Fail to reject	Fail to reject	Fail to reject
ARCH(1)	arch0,arch1	3569.854	3914.29/3919.52	Fail to reject	Fail to reject	Fail to reject	Fail to reject

Table 12: Testing for Feedback Between Each Country's Industry Group and Its Associated Financial Sector

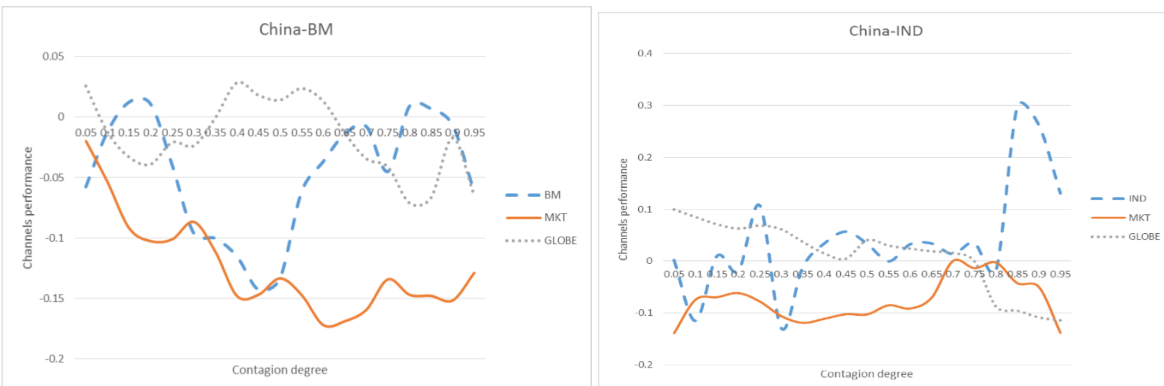
This table reports the Granger Causality test results of whether a shock spreads from an individual sector to its financial sector. The null and alternative hypotheses are as follows. H_0: No Granger causality (no shock spreads from an individual sector to the financial sector). H_a: Granger causality (shock does spread from an individual sector to the financial sector). We report chi-statistics and p-values. Industry abbreviations are as follows: Oil and gas (OIL), basic materials (BM), industrials (IND), consumer goods (CNS), health care (HL), consumer services (CN), telecommunications (TEL), utilities (UT), financials (FIN), technology (TEC), total market return (MKT).

China			***CZ***			***Malaysia***			***Colombia***		
Industry	Chi-sq	Prob.	*Industry*	Chi-sq	Prob.	*Industry*	Chi-sq	Prob.	*Industry*	Chi-sq	Prob.
BM	6.83	0.74	*CN*	42.71	0.06	*BM*	36.09	0.03	*CN*	27.04	0.93
CNS	8.01	0.63	*HL*	17.86	0.96	*CNS*	28.11	0.17	*OIL*	29.26	0.87
CN	12.22	0.27	*OIL*	35.10	0.24	*IND*	23.36	0.38	*UT*	36.19	0.60
OIL	13.03	0.22	**Hungary**			*UT*	25.43	0.28	**Philippines**		
UT	14.84	0.14	*Industry*	Chi-sq	Prob.	**Poland**			*Industry*	Chi-sq	Prob.
India			*BM*	26.10	0.62	*Industry*	Chi-sq	Prob.	*CNS*	22.43	0.72
Industry	Chi-sq	Prob.	*CN*	33.16	0.27	*CNS*	38.60	0.11	**Turkey**		
IND	15.27	0.58	*HL*	33.24	0.27	*IND*	27.22	0.56	*Industry*	Chi-sq	Prob.
Chile			*OIL*	18.24	0.94	***Russia***			*BM*	7.58	0.18
Industry	Chi-sq	Prob.	*TEL*	19.37	0.91	*Industry*	Chi-sq	Prob.	***Thailand***		
BM	53.67	0.03	*UT*	28.15	0.51	*BM*	11.93	0.02	*Industry*	Chi-sq	Prob.
CNS	52.42	0.04	*Korea*			*OIL*	5.38	0.25	*BM*	31.95	0.28
CN	31.90	0.66	*Industry*	Chi-sq	Prob.	*UT*	37.22	0.14	*CNS*	29.39	0.39
HL	34.30	0.55	*BM*	12.90	0.84	***South Africa***			*HL*	38.88	0.08
IND	18.89	0.99	*IND*	15.14	0.71	*Industry*	Chi-sq	Prob.	*IND*	35.24	0.16
OIL	28.26	0.82	*OIL*	21.74	0.30	*BM*	3.71	0.59	*OIL*	26.60	0.54
UT	35.74	0.48	*UT*	7.55	0.99						

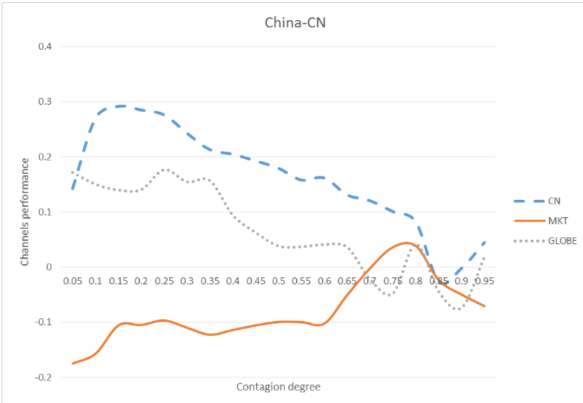
FIGURES

Figure 1: The structure of channel performance as the severity of contagion increases

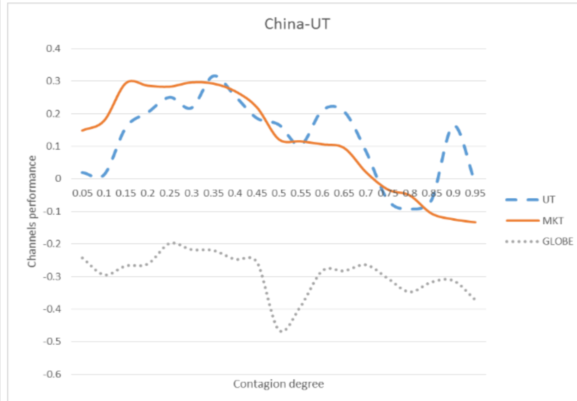
We estimate equation (11) using a quantile regression approach following ***Baur (2013)*** and using *Equation (12):* $Q(\tau)_{Contg_{i,j,t}} = \gamma_{0\ i,j}(\tau) + \gamma_{1\ i,j}(\tau)\sigma_{i,j,t} + \gamma_{2\ i,j}(\tau)\sigma_{j,t} + \gamma_{3\ i,j}(\tau)\sigma_{wd,t}$ (i is sector, j is country and τ is quantile, i.e. 5^{th} 10^{th} 15^{th} …95^{th} . $Q(\tau)$ represents the τth quantile regression). $\gamma_{0,i,j}(\tau)$ is the intercept of the τth quantile regression while $\gamma_{1\ i,j}(\tau)$, $\gamma_{2\ i,j}(\tau)$, and $\gamma_{3\ i,j}(\tau)$ are the coefficients of τth quantile regression. $\sigma_{i,j,t}$ is estimated from equation (4) and is the idiosyncratic volatility of sector i in country j at time t, $\sigma_{j,t}$ is estimated from equation (7) and is the idiosyncratic volatility of country j at time t and $\sigma_{wd,t}$ is estimated from equation (10) and is the idiosyncratic volatility of world at time t. $\sigma_{i,j,t}$, $\sigma_{j,t}$ and $\sigma_{wd,t}$ each have 95 observations. $Contg_{i,j,t}$ has 95 observations and is estimated by the Kalman filter. The x-axis is the contagion degree and the y-axis is the $\gamma_n(\tau)$, n=1,2,3. The industry abbreviations are as follows: Oil and gas (OIL), basic materials (BM), industrials (IND), consumer goods (CNS), health care (HL), consumer services (CN), telecommunications (TEL), utilities (UT), financials (FIN), technology (TEC) and total market return (MKT).



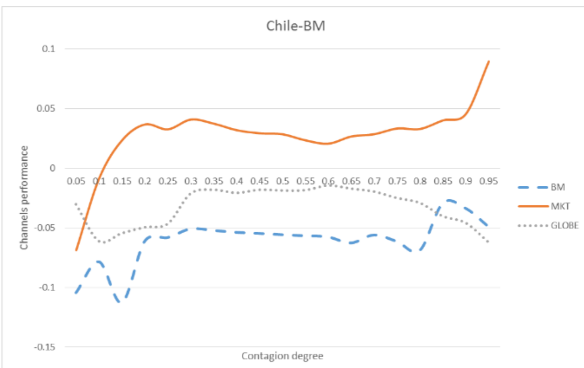
(a) (b)


China-CN
Channels performance
Contagion degree
0.4
0.3
0.2
0.1
0
-0.1
-0.2
0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7 0.75 0.8 0.85 0.9 0.95
CN
MKT
GLOBE

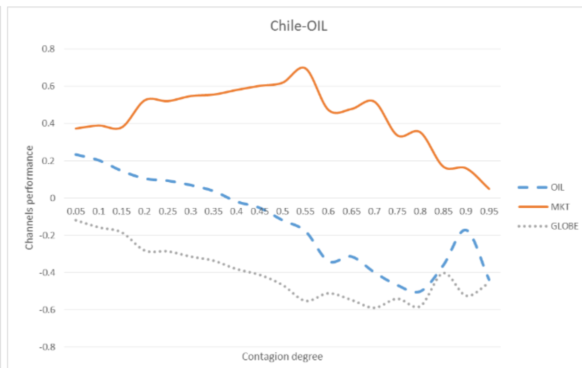
(c)


China-UT
Channels performance
Contagion degree
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7 0.75 0.8 0.85 0.9 0.95
UT
MKT
GLOBE

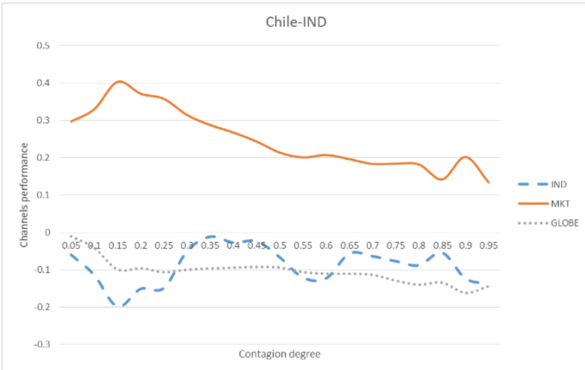
(d)


Chile-BM
Channels performance
Contagion degree
0.1
0.05
0
-0.05
-0.1
-0.15
0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7 0.75 0.8 0.85 0.9 0.95
BM
MKT
GLOBE

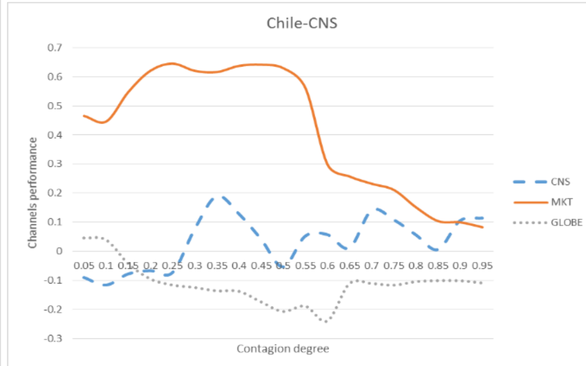
(e)


Chile-OIL
Channels performance
Contagion degree
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7 0.75 0.8 0.85 0.9 0.95
OIL
MKT
GLOBE

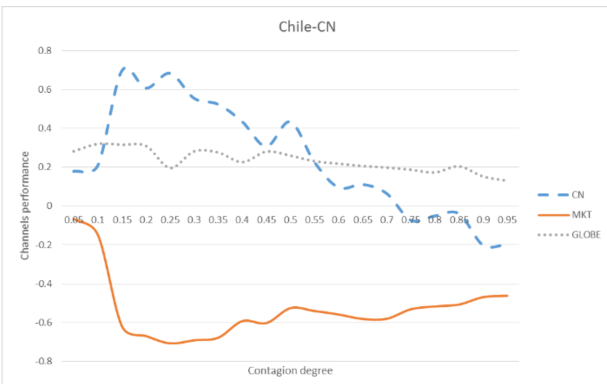
(f)


Chile-IND
Channels performance
Contagion degree
IND
MKT
GLOBE

(g)


Chile-CNS
Channels performance
Contagion degree
CNS
MKT
GLOBE

(h)


Chile-CN
Channels performance
Contagion degree
CN
MKT
GLOBE

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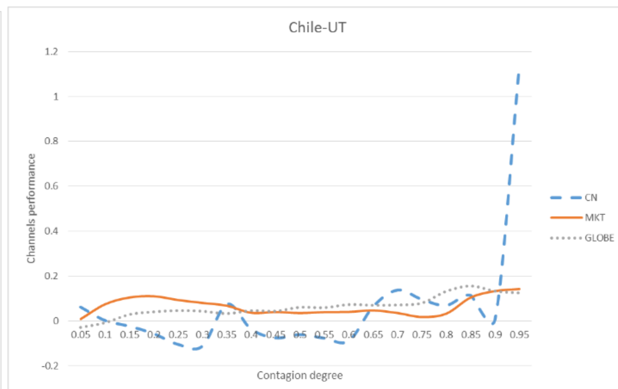
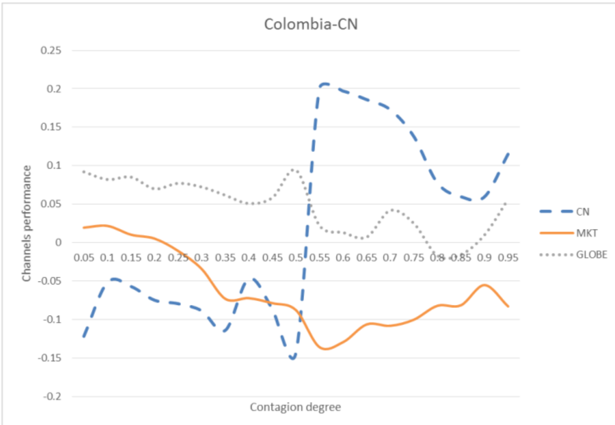
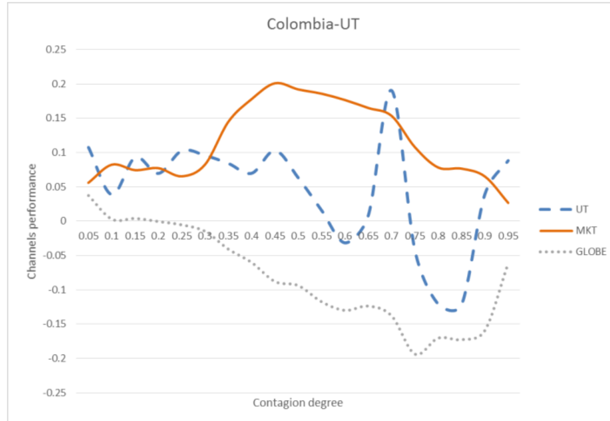

Chile-UT
Channels performance
Contagion degree
CN
MKT
GLOBE

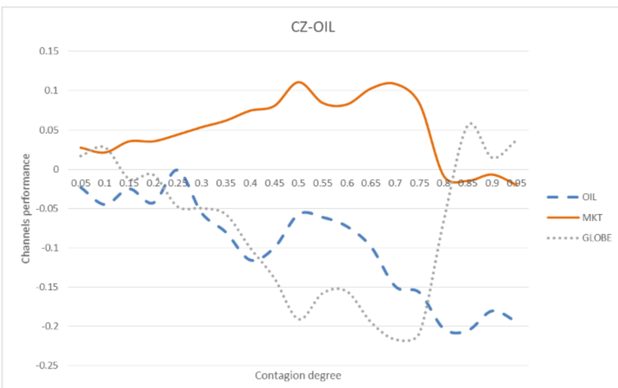
(j)


Colombia-CN
Channels performance
Contagion degree
CN
MKT
GLOBE

(k)


Colombia-UT
Channels performance
Contagion degree
UT
MKT
GLOBE

(l)


CZ-OIL
Channels performance
Contagion degree
OIL
MKT
GLOBE

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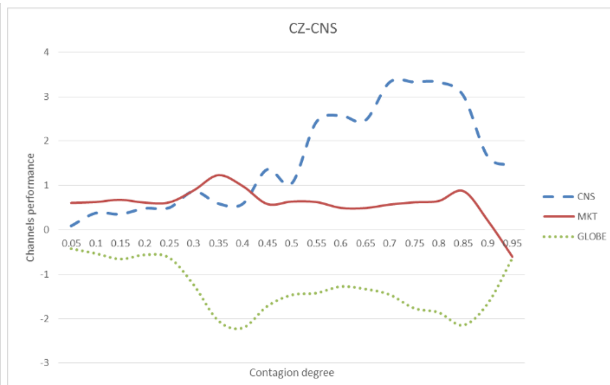
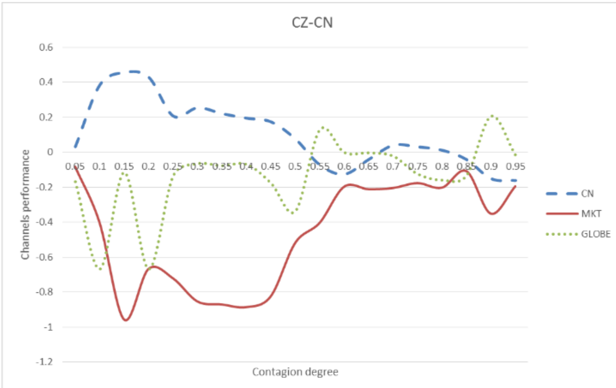
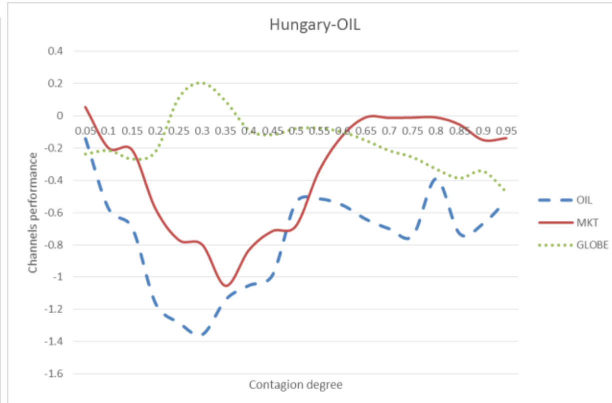

CZ-CNS
Channels performance
Contagion degree
CNS
MKT
GLOBE

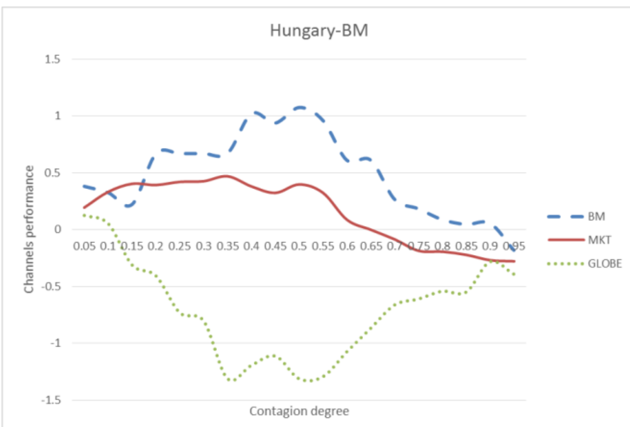
(n)


CZ-CN
Channels performance
Contagion degree
CN
MKT
GLOBE

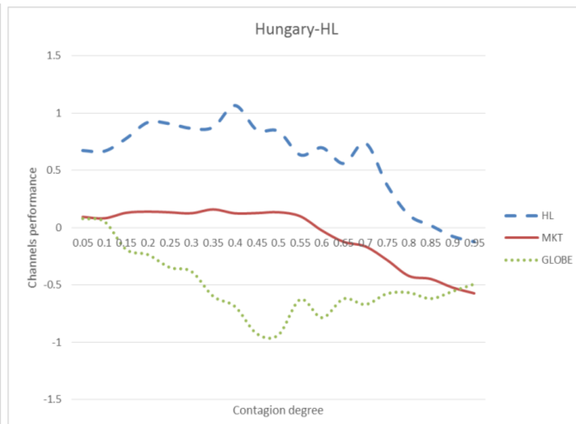
(o)


Hungary-OIL
Channels performance
Contagion degree
OIL
MKT
GLOBE

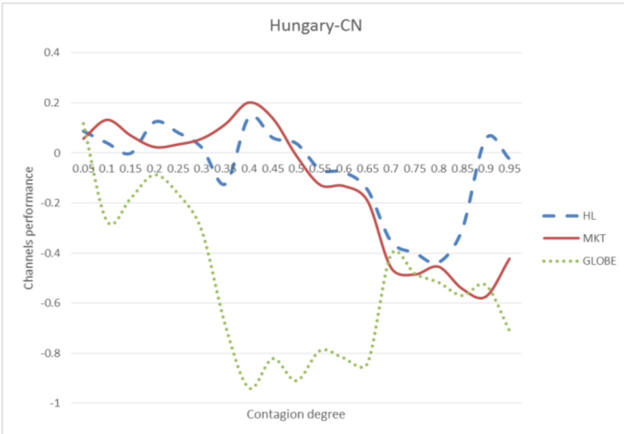
(p)


Hungary-BM
Channels performance
Contagion degree
BM
MKT
GLOBE

(q)


Hungary-HL
Channels performance
Contagion degree
HL
MKT
GLOBE

(r)


Hungary-CN
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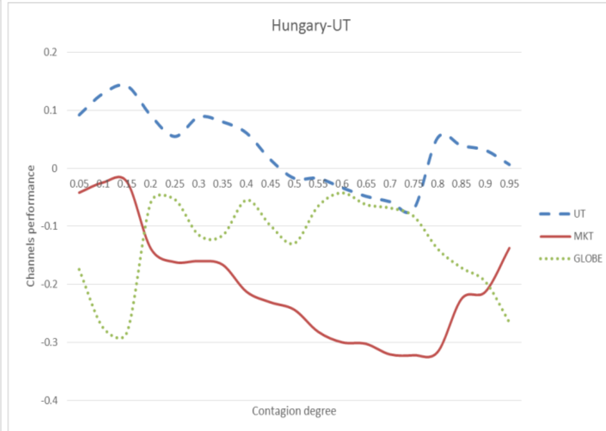
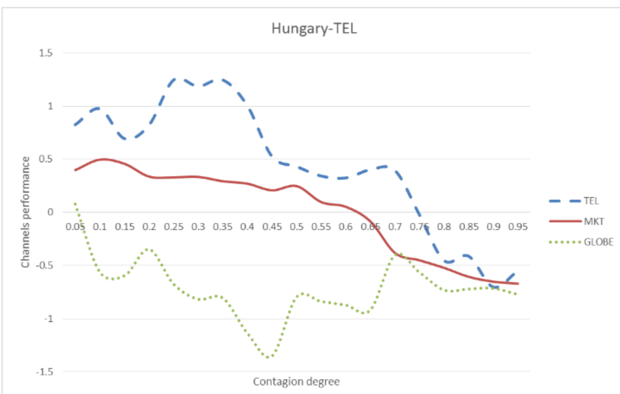
0
-0.2
-0.4
-0.6
-0.8
-1
0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7 0.75 0.8 0.85 0.9 0.95
Channels performance
Contagion degree
HL
MKT
GLOBE

(s)


Hungary-UT
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7 0.75 0.8 0.85 0.9 0.95
Channels performance
Contagion degree
UT
MKT
GLOBE

(t)


Hungary-TEL
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1
0.5
0
-0.5
-1
-1.5
0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7 0.75 0.8 0.85 0.9 0.95
Channels performance
Contagion degree
TEL
MKT
GLOBE

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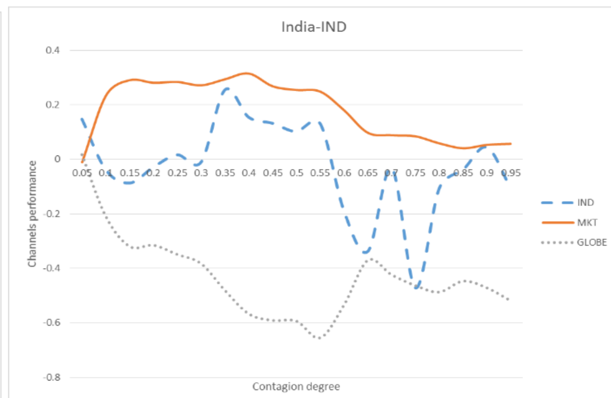
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0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7 0.75 0.8 0.85 0.9 0.95
Channels performance
Contagion degree
IND
MKT
GLOBE

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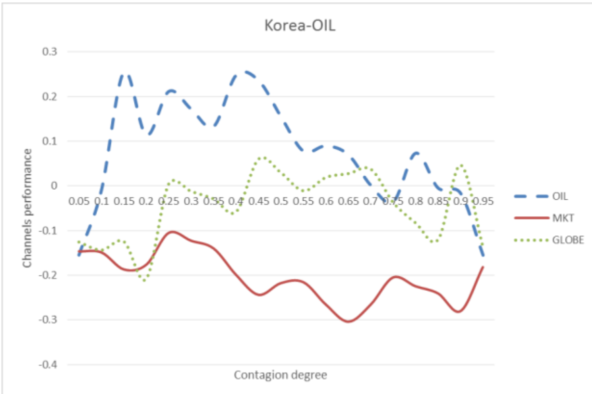
Korea-OIL
Channels performance
Contagion degree
OIL
MKT
GLOBE

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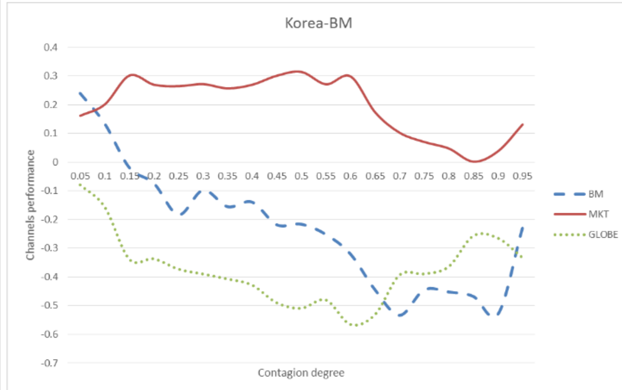
Korea-BM
Channels performance
Contagion degree
BM
MKT
GLOBE

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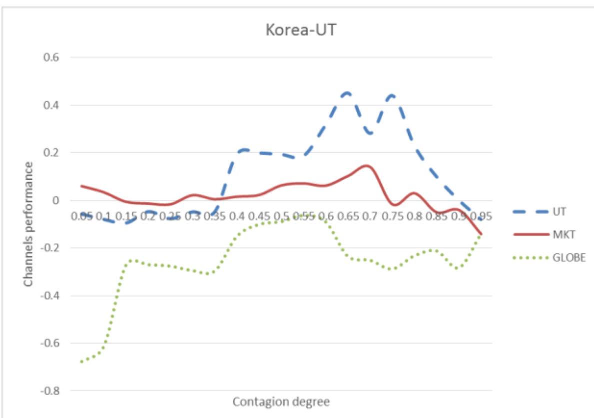
Korea-UT
Channels performance
Contagion degree
UT
MKT
GLOBE

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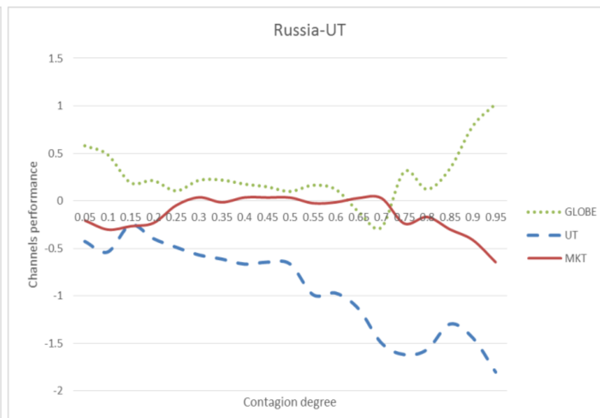
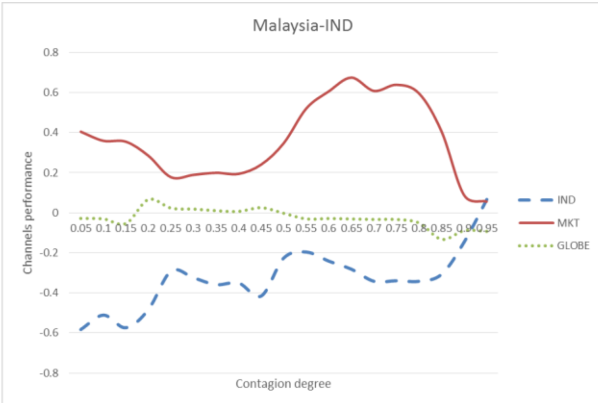

Russia-UT
Channels performance
Contagion degree
GLOBE
UT
MKT

(z)


Malaysia-IND
Channels performance
Contagion degree
IND
MKT
GLOBE

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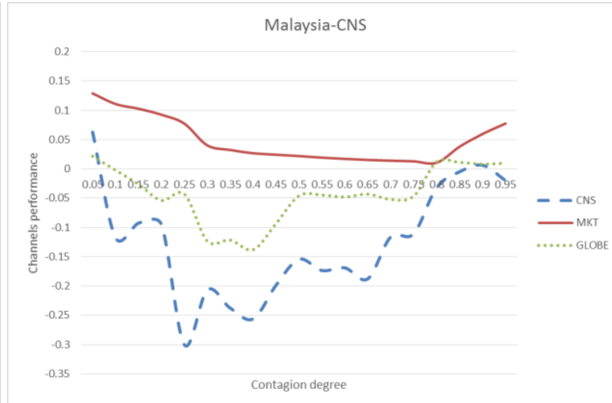
Malaysia-CNS
Channels performance
Contagion degree
CNS
MKT
GLOBE

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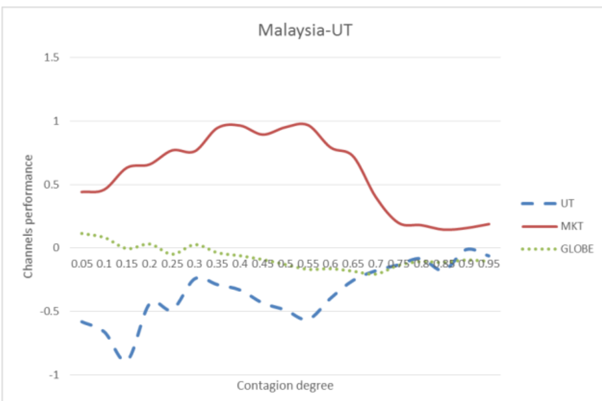
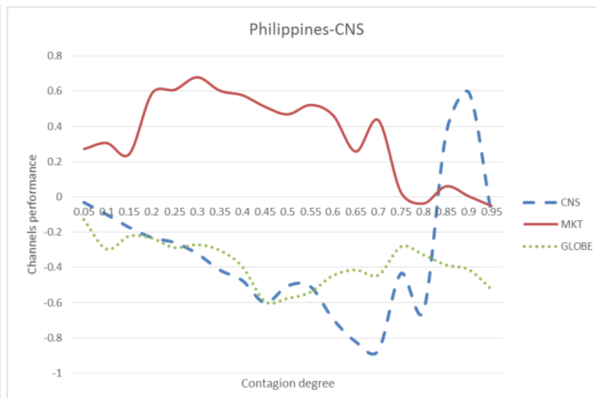
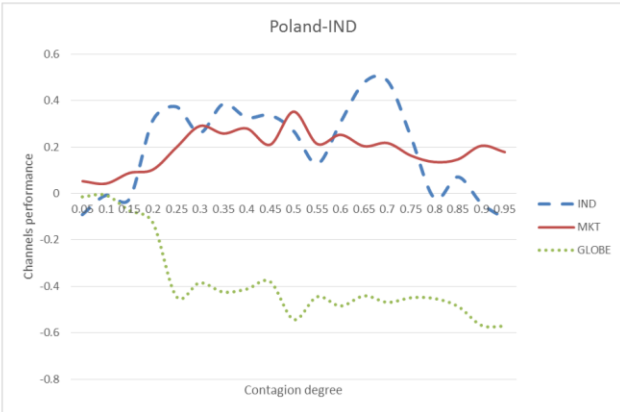

Malaysia-UT
Channels performance
Contagion degree
UT
MKT
GLOBE

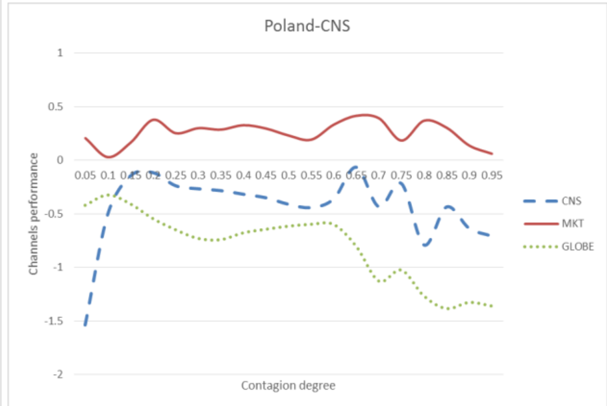
(ac)


Philippines-CNS
Channels performance
Contagion degree
CNS
MKT
GLOBE

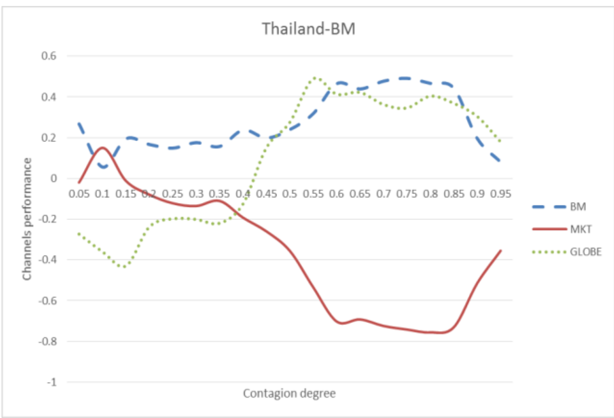
(ad)


Poland-IND
Channels performance
Contagion degree
IND
MKT
GLOBE

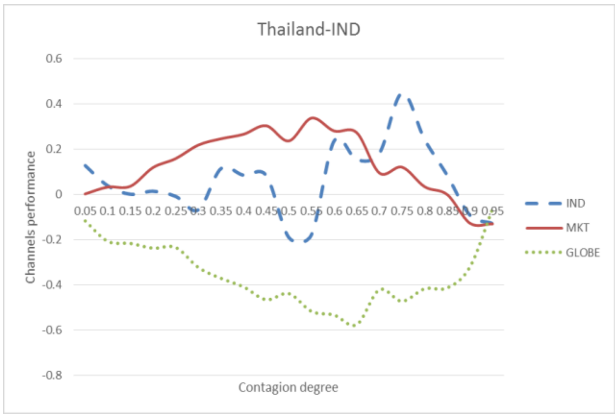
(ae)


Poland-CNS
Channels performance
Contagion degree
CNS
MKT
GLOBE

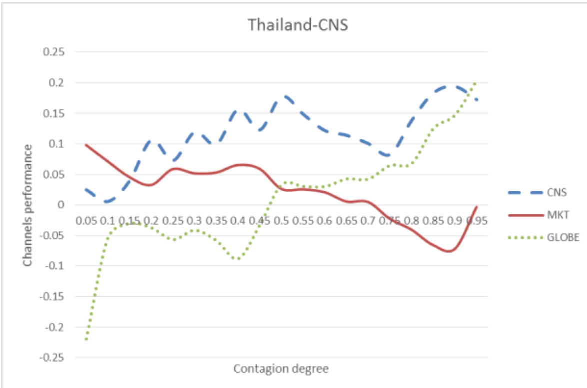
(af)


Thailand-BM
Channels performance
Contagion degree
BM
MKT
GLOBE

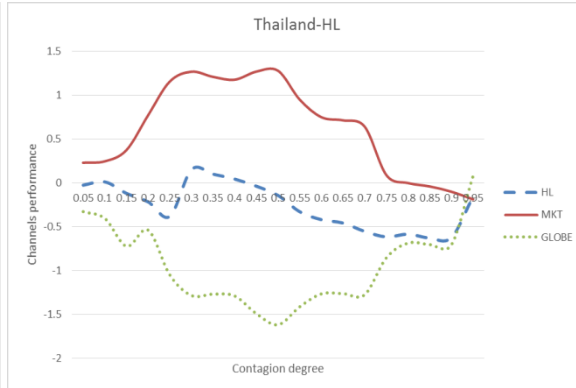
(ag)


Thailand-IND
Channels performance
Contagion degree
IND
MKT
GLOBE

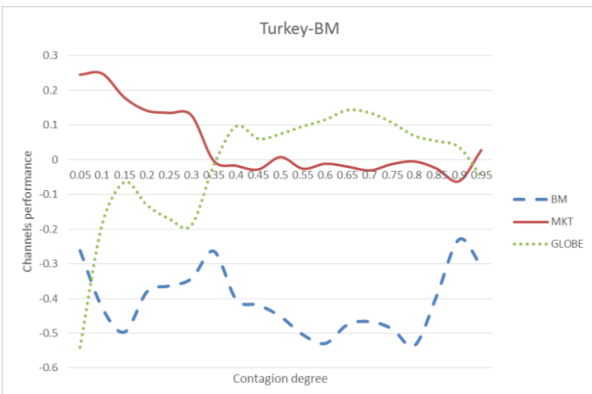
(ah)


Thailand-CNS
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
Channels performance
0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7 0.75 0.8 0.85 0.9 0.95
Contagion degree
CNS
MKT
GLOBE

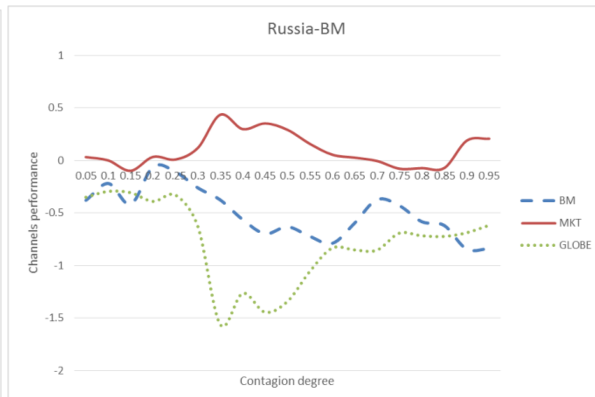
(ai)


Thailand-HL
1.5
1
0.5
0
-0.5
-1
-1.5
-2
Channels performance
0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7 0.75 0.8 0.85 0.9 0.95
Contagion degree
HL
MKT
GLOBE

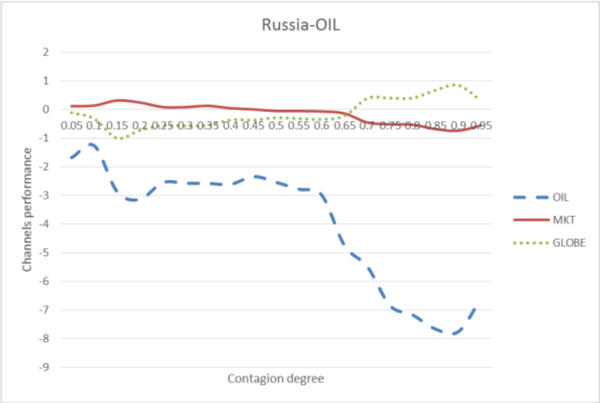
(aj)


Turkey-BM
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
Channels performance
0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7 0.75 0.8 0.85 0.9 0.95
Contagion degree
BM
MKT
GLOBE

(ak)


Russia-BM
1
0.5
0
-0.5
-1
-1.5
-2
Channels performance
0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7 0.75 0.8 0.85 0.9 0.95
Contagion degree
BM
MKT
GLOBE

(al)


Russia-OIL
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7 0.75 0.8 0.85 0.9 0.95
Channels performance
Contagion degree
OIL
MKT
GLOBE

(am)